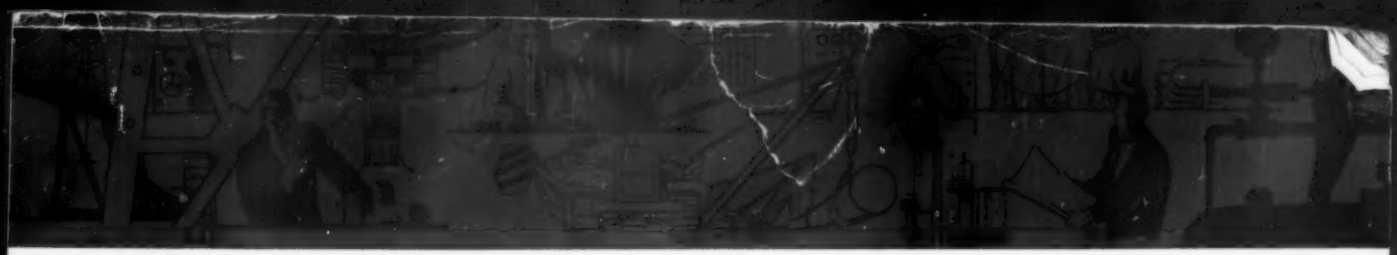


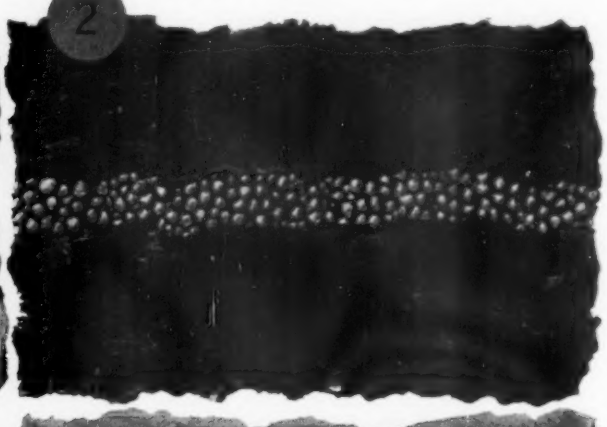
Petroleum Management

A PETROLEUM ENGINEER PUBLICATION December, 1961

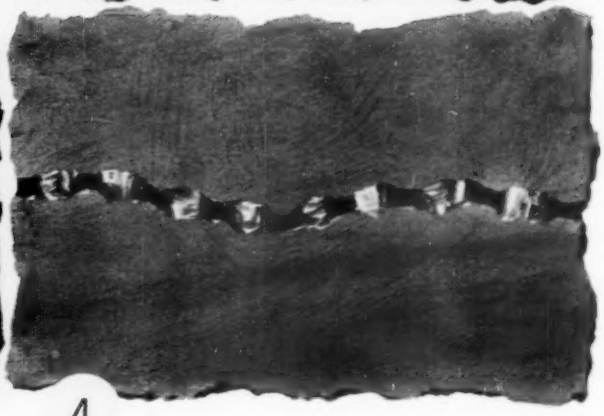
Gas Invades Europe's Energy Market
Price Wars Hit Third Quarter
Merit Rating the Engineer
Do We Need Fuel Policy?
The Management Game
Catalytic Alkylation
Frac Plan Pays Off
Canada Has Historical Pipeline Year
Heat Exchanger Design Variables
Special Rig Tackles Deep Workovers

Widely-spaced malleable props, such as rounded walnut shells, propping a fracture in a hard homogeneous formation with high overburden pressure.

Sand fully packed into a fracture in a homogeneous formation with low permeability and moderate overburden pressure.



No prop is used in an acid-soluble, heterogeneous formation. Retarded Acid etches formation, leaving less soluble portions as prop.



Closely-spaced malleable props, such as aluminum pellets, propping a fracture in a medium-hard to soft homogeneous formation with high overburden pressure.

fracture conductivity tests help operators select most profitable stimulation treatments

For more than a year, Dowell laboratories have been measuring and compiling data on flow capacities of fractures in various formations. The effects of different fracturing fluids and propping agents on fracture conductivity are compared. The illustrations here show four examples of fracture props that are frequently checked.

Flow capacity data from these tests — plus other pertinent well information — are interpreted through the Frac Guide* by Dowell engineers to help design the most profitable fracturing treatments for you.

In many cases, operators have realized much faster payouts than had been recognized as normal for a field. In some instances, Dowell has helped operators avoid many unprofitable jobs. In most cases, average profits have been increased over previously accepted norms.

In designing a stimulation treatment, it is best to test actual cores from your well. However, if cores are not available, cuttings can often be used. These cuttings are compared for similarity with the numerous cores already tested and cataloged by Dowell.

Ask your Dowell representative for a free copy of the new "Technical Report on Fracture Conductivity." It deals with such factors as size, type and amount of propping agent, hardness of formation and overburden pressure.

The fracture conductivity testing program is another important step in Dowell's continuing research and service program to help you make more profits. Dowell services and products are offered in North and South America, Europe and North Africa. Dowell, Tulsa 1, Oklahoma.

*DOWELL SERVICE MARK

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DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

A Christmas Message from the Publisher

One Solitary Life

Here is a young man who was born in an obscure village, the child of a peasant woman. He grew up in another village. He worked in a carpenter shop until he was thirty and then for three years he was an itinerant preacher. He never wrote a book. He never held office. He never owned a home. He never had a family. He never went to college. He never put his foot inside a big city. He never traveled two hundred miles from the place where he was born. He never did one of the things that usually accompany greatness. He had no credentials but himself. ¶ While he was still a young man, the tide of public opinion turned against him. His friends ran away. He was turned over to his enemies. He went through the mockery of a trial. He was nailed to the cross between two thieves. While he was dying, his executioners gambled for the only piece of property he had on earth, and that was his coat. When he was dead, he was laid in a borrowed grave through the pity of a friend. ¶ Nineteen wide centuries have come and gone, and today he is the central figure of the human race and the leader of the column of progress. ¶ I am far within the mark when I say that all the armies that ever marched, and all the navies that were ever built, and all the parliaments that ever sat, and all the kings that ever reigned, put together, have not affected the life of man upon this earth as has this one solitary life.

— ANONYMOUS

News

McCOLLUM HEADS API

L. F. McCollum, president of Continental Oil, was elected board chairman of American Petroleum Institute. He succeeds M. J. Rathbone. E. D. Brockett, president of Gulf, was named vice president for transportation succeeding Henderson Supplee Jr. J. C. Donnell II, president of Ohio Oil, was presented the API's Carl A. Young memorial award.

RAISED TO 9 DAYS

Nine days production in December was set for Texas by the R. R. Commission after 7 months of 8-day schedules. Requests for extra day came from Humble, Sun, Sinclair, StanCal, Socony Mobil. Recommending 8 days were: Phillips, Shell, Cities Service, Continental, Standard (Ind.), Texaco, Gulf.

OUTLAW PRICE WARS

Just when gains in industry and business are going top cycle again, petroleum stubs its profits on price wars. The third quarter showed an 8% earnings on record revenue. In 1960 profits were 8.8% of gross income. Nine months of 1961, however, made 8.4% of gross compared to 8.2% for nine months in 1960 (see page 38).

GOES INTO ARGENTINA

Cities Service acquired a major interest in the operation and development of producing properties in Argentina. Output averages 23,000 b/d, or about 10% of Argentina's total. Cities Service purchased L. R. Development, Ltd., which owned majority interest in a contract with YPF, government oil company, for a million-acre concession in the Argentine.

EQUIPMENT EXPORTS DIP

Exports of U. S. oilfield equipment were 16.6% less for the first half of 1961 than last year. In 1961 exports totaled $79,700,000; in 1960 they were $95,500,000. About 86% of the drop was due to lower totals in drilling rigs and equipment. Most U. S. rig manufacturers have licensed European firms.

OEEC OIL DEMAND UP

Oil consumption in West European nations continued at a brisk 12% rise. OEEC nations averaged 12% annual increase in demand during the '50s. In the first half of 1961 sales rose 20½% in West Germany, 14½% in Italy, 10% in United Kingdom and 9% in France.

USSR UPS OIL PRICE

Sojus Neft Export, Moscow, is raising prices for gasoline, gas, oil and heavy fuel oil by about $2 a ton in new agreements in 1962, according to German Oil Information Service. Soviet authorities declare that demand for Russian oil is so heavy the state can afford to raise the price.

News

DEMAND UP 5.4%

Total movement of petroleum products was 5.4% higher in October than a year ago, Chase Manhattan Bank says. For the first 10 months total demand was 1% more than 1960. Inventory totals 868,358,000 bbl, an all-time high.

BOUGHT AND SOLD

Cities Service acquired Fairway Oil and Gas which has interests in Fairway field, Tex. . . . Humble plans to exchange Jersey stock for Olin Oil and Gas (equivalent to about $68 million). . . British-American Oil Producing purchased Weston and Largo Drilling properties in Mississippi for $3,000,000 . . . Atlantic made an offer for Argo properties for part cash and remainder production payments . . . Pan American and Tidewater have completed purchase of Honolulu Oil properties . . . Signal bought Century Oil, which had a 5000 b/d refinery and a small chain of stations around Los Angeles . . . Commonwealth Oil, Houston, and Jupiter Oils, Chicago, will merge with Jupiter as survivor.

TRINIDAD GETS PLANT

Texaco will build a 2700 b/d lubricating plant at Pointe-a-Pierre, Trinidad, next to its 235,000 b/d refinery. Work on the new $27,000,000 installation will begin early in 1962 and completion is expected in 1964.

SETS UP SWISS FIRM

Phillips Petroleum has established branch firm in Zurich, according to Swiss press. It will deal with purchase and sale of petrochemical products and machinery and equipment and will engage in research and development of organic and inorganic chemicals, including petroleum and natural gas, as well as sale and purchase of patents and licenses.

HELIUM PLANT OPENED

Kerr-McGee's helium extraction plant, near Navajo, Arizona, began production in November. Under state conservation laws the company uses 1700 Mcf/d of raw gas which contains about 8% helium. The plant has a 2500 Mcf/d capacity.

ARAMCO SELLS GAS

First sale of natural gas for industry in Saudi Arabia was made by Aramco this fall to Saudi Cement Co., near Abqaiq. A maximum of 3600 Mcf/d of gas is transported by 8-in. pipeline from Shedgum to cement plant 8 miles away. Although a small operation, it points up growing use of gas energy (see page 32).

YEAR OF OIL STATIC

Bureau of Mines just released the figures for last year. U. S. oil production was 19,000 b/d less than in 1959; imports 50,000 b/d more (products imports 15,000 b/d less); crude stocks went down 47,000 b/d; crude demand increased 64,000 b/d. Domestic product demand rose 2.2%; total demand 2.1%; refining runs were record high 1.2% above 1959; products stocks dropped 3.2%, a decrease of 17,000,000 bbl.

News

HELIUM PRICES JUMP

Wholesale prices went from $19 to $35/Mcf for helium November 18. Bureau of Mines set the new rates in order to carry out the 1960 Helium Act. Retail prices, not set by government, vary from $60 to $110. Increased revenue to B of M will finance new conservation program. Government agencies are principal purchasers.

NEW PETROCHEM COMPLEX

Union Texas Natural Gas and Allied Chemical will build a petrochemical complex near Baton Rouge, La., on a 2000-acre site. The two companies have formed (50-50) Allied-Union Texas Petrochemicals to operate the $40 to $60 million plant, which will handle some 25,000 b/d liquids. It is expected to be in operation in mid-1963.

FUEL STUDY BROADENED

A complete energy picture will be drawn up for the Senate Committee study on the need for a national fuels policy (see pages 50 and 51). Samuel G. Lasky, on loan from Interior Department's Office of Coal Research said the report, to be ready February 1, will deal with electricity, coal, oil, gas nuclear and solar energy.

PAKISTAN STARTS OIL FIRM

The new Pakistan ordinance to establish a national oil company has been carried out. The company has an initial capital of $2,100,000, expected to be increased to $10,-500,000; money to be raised by a surtax on foreign oil companies. Oil and Gas Development Corporation's first job is supervising Soviet technicians for exploration. USSR has allowed a $30,000,000 credit to pay for equipment and men.

PLANTS PLANNED

In India Montecatini of Italy will invest $21,000,000 with a new local firm in a polypropylene unit. A British team is preparing a prospectus for an oil refinery in East Pakistan.

GETS ARAB ACREAGE

Pan American International (Standard Indiana) has acquired a 45,000-square-mile concession in the Hadhramaut, Southern Arabian Peninsula. The contract states 55% of the net profit will go to the two state governments which also have option to participate up to 20%.

INVITES PROPOSALS

Plymouth Oil has asked companies interested in acquiring it to submit merger proposals. Paul G. Benedum, Sr., president, said his firm would like to examine all proposals at one time. The deadline was reported to be the end of November. Benedum said Plymouth isn't sure it will accept any offer.

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Petroleum Management®

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Course of Oil

All for a Nickel

You're on a vacation motor trip — you, the wife and the three chips off the two old blocks. You stop at the service station and say "fillerup." (You know the tank can't hold much, but somebody in five is always needing a stop.)

The family piles out and heads for the rest rooms. You go in and get a free map to check the route again and ask the manager "Where's a good place to eat on the highway?"

The men outside wipe the windshield and the glass all the way around. One checks the tires and then the oil.

"A quart low, sir."

"I need an oil change in another 500 miles. Will it do till then?"

"It'll do."

The automatic hose has turned off. Your tank is full. It took five gallons of gasoline. You pay $1.58 and you and your family roar off, knowing that the next hundred miles you'll have a choice of many other service stations to hold your hand, so to speak, on this journey of yours.

Did you know that the man who told you the best highway to take and where you could get a good meal, who gave you the map, supplied the rest rooms, hired the men who cleaned your windows and checked your oil and battery and tires, netted less than a nickel on your visit?

He has a mark-up of some 27¢ on the sale but he has to pay employees, rent, taxes, buy equipment and supplies, collect excise taxes and pass them on, and make contributions to community affairs out of that 27¢.

You paid the government — federal and state — 51¢ (national average on five gallons) mostly for the highways you ride on, but also in some states for pensions, teachers' salaries, welfare funds, administration—whatever state officials decide the tax should be spent for.

The remaining 80¢ goes to an army of people ... to the wholesaler, who has those big tank trucks that keep the station supplied with gasoline (did you ever go into a station that had run out of gasoline?) ... to the pipeline, railroad, barge or truck company that does the transporting ... to the refinery that turned a viscous crude oil into the sparkling energy you bought ... to the producers who bring the oil from deep below the earth's surface ... to the engineers who learn how to recover two barrels of oil where only one could be counted on before ... to the drillers who sweated a pipe down to the right spot to tap an oil reservoir ... to the explorers who combed the land to find on indication of petroleum trapped far beneath the earth they stood on ... to the farmer who owned the land ... to lawyers, to accountants, to managers. For its fabulous operations that brought the gasoline to the service station, the industry made a profit of 6½¢ (average in 1960). Where in all the world could you find such a buy as the five gallons of gasoline you bought to carry your car and you and your family and your luggage almost a hundred miles?

Like parents, the petroleum industry preserved a myth that it is another Santa Claus — pulling gifts from a bottomless sack. Some day, some time, our customers must learn (as Dear Virginia was told) that our industry is a spirit, too — a flaming spirit of enterprise and courage, an intense spirit of research and exploration, a determined spirit of economics and logistics. Our gifts are not drawn from a magical bag. They are worthy products of mind and inspiration and labor. Won't you recognize the bargain you have won — the achievement behind that gasoline you buy?

— Ernestine Adams

(Received Desk and Derrick award for best editorial in 1961)

Congrats and $25 to Peter Fernandez, Texaco T'Dad Inc. 18 Concord Road, Pointe-a-Pierre Trinidad, W.I.

Joe Roughneck is apt to set up a howl, too, if asked to handle steel pipe that is less than superior.

More and more experienced oil and gas men have switched to Lone Star API casing, tubing and line pipe, because it's "tough, top quality and delivered fast." Your best guarantee of rugged API standards is Lone Star's uncompromising quality control.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

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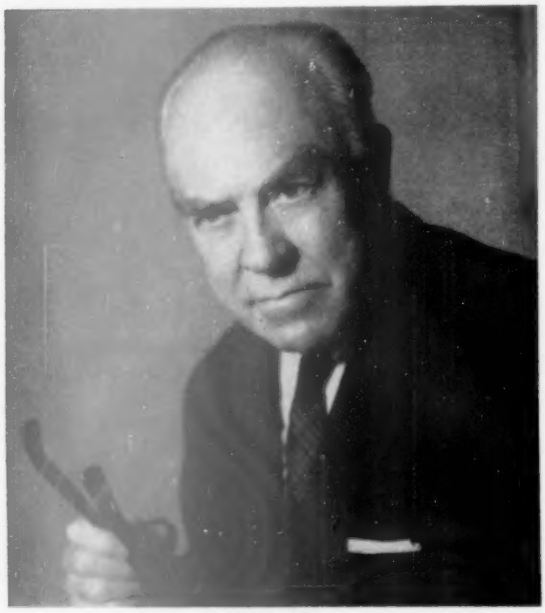
Profile



F. Kirk Johnson

When you get started on the activities of F. Kirk Johnson, there's no stopping place. He began as teacher and coach, and now his businesses are many. He is an oilman first. He has an airline, foreign car distributorship, TV and radio stations, cattle ranches, an olive ranch, racing stable and collects paintings and guns. These are only the principal interests.

Maybe his schooling prepared him for this full line of diverse business. Born in Nebraska, his early days were spent in Western Canada, where he studied civil engineering and teaching; (he just inherited coaching football and hockey); at the University of Chicago he studied geology. In January 1917, he went to France attached to the French Army. Back home he first ranched in Wyoming. Then he married Elizabeth McGhee, a Chicago girl, and entered the oil business the same red letter year of 1921. They moved to Texas, and he drilled his first dry hole on the Waggoner Ranch. It wasn't until 1928 that Gibson and Johnson made a big discovery in Winkler County, Texas.

In the early thirties Johnson moved to Fort Worth and as an individual got into producing, refining and marketing. He had three refineries in Texas; discovered fields in Texas, Michigan and Kentucky.

Ambassador Oil Corporation was formed in December 1955, with Johnson as president and chairman of the board.

Ambassador now produces in excess of 20,000 gross barrels of oil per day. Many field discoveries made by Ambassador have been named after "Kirk," such as Wendkirk field, Frankirk field, Abkirk, Kenkirk, Newkirk, etc.

Last year Ambassador took a concession of 20 million acres covering all the Republic of Ireland, except the six North British counties. Continental Oil and Ohio Oil each bought an undivided interest in the venture later.

In 1949 Johnson financed and activated Central Airlines, Inc., a local service airline, with Johnson chairman of the board.

Mr. Johnson's main hobbies have been polo, racing, hunting, fishing and stocking a wine cellar. In 1942, he started the Live Oak Stable, which he now owns with Jimmy Stewart, the actor. They have horses in England, Ireland, Panama, and California.

Johnson's hunting and fishing have involved trips to Africa, India, South America, Mexico, Alaska, Canada and the Orient. He is president emeritus of the Fort Worth Zoological Association. Mrs. Johnson accompanies him on these expeditions and in recent years, Gloria and Jimmy Stewart have been with them. This year they had a 40-day safari in Africa.

Johnson and Stewart have many joint ventures — cattle ranches in Texas and South Dakota, an olive ranch in Brazil, and TV and radio stations.

When foreign cars became the rage, Johnson took on the distributorship for most of the Southwest for Rolls Royce, Jaguar, Fiat, etc.

On his personal ranch he runs cattle, has a thoroughbred horse breeding farm, and raises imported game animals and birds.

Of all of his possessions, he cherishes most his collection of original oil paintings of African game by the great German artist, William Kuhnert. He has 35 originals. The second largest collection of 18 Kuhnerts is in the National Museum in Enschede, Holland. His gun collection has many rare items.

Johnson's family consists of a daughter, Mrs. William Mitsch, of Fort Worth, who has two children, and his son, F. Kirk Johnson, Jr., who has three children.

His many business ventures have ranged from a Dude Ranch called "Vallejo" in New Mexico to an interest in Alexis Lichine's Chateau Lascombes in France and his latest diversification is joining with friends in "angeling" a Broadway play. He is a hard man to pin to a single career. But he's always trying to do some pinning himself — like the two expeditions he and Tom Slick sponsored to Nepal in search of the Abominable Snowman.

"My Cat 561 can handle about any job in the oil field"

—W. R. FERGUSON

clearing right of way • stringing pipe • lowering in pipe • taking up old pipe • installing valves • backfilling • handling pipe and equipment in storage yards • light steel and tank erection • right of way maintenance • emergency repairs • snow removal

HANDLING PIPE FOR TIE-IN

SETTING IN A GAS METER RUN

PLACING PRESSURE REGULATOR

BACKFILLING WITH ANGLE-DOZER

"Fast and economical," is the report from the Ferguson Construction Co. on their new Cat 561 Pipelayer.

With its Balderson-built angle-dozer and the extra dealer-built 27′ boom, the 561 has the ability to handle nearly every phase of pipeline and light steel erection work in this gathering field in the Permian Basin, New Mexico.

Owner W. R. Ferguson gave a few details on the variety of jobs they handle with the 561: "Besides the usual assignments of construction and maintenance work, we found the 561 was very efficient taking up old pipe. The 561 can cradle the pipe up out of the ditch and backfill with its dozer as it moves ahead. And since the ditch is filled in, the pipe lays on the surface and doesn't bend.

"The 561's mobility is a convenience too. We don't have to have extra-heavy equipment to haul it around . . . there's nothing but clear-cut economy with the 561—we have one machine to handle many phases of a small job—rather than tying up two machines or more."

If you're interested in handling a two-machine job with *one* 561—see your Caterpillar Dealer. He'll be happy to fill you in with the facts on the 561—its counterweight arrangements for up to 38,800-lb. lifts, its Cat-built oil clutch, lifetime lubricated rollers, easy controls and many other features. Just call your Caterpillar Dealer.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U. S. A.

CATERPILLAR

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CAT PIPELAYERS FOR THE HARD WORK

Conference Table

Says No to Exemption

In an interview with FPC Chairman Joseph C. Swidler (Petroleum Management, October 1961) he said he favored excluding small gas producers from Federal Power Commission control if it were possible and he thought the Commission had the authority to do so. In October Howard Morgan, FPC vice chairman, said the agency does not have this authority to exempt small producers. In a speech to the West Texas Oil and Gas Association, Commissioner Morgan said the idea was attractive because the bulk of FPC work is concerned with thousands of producers who account for a minority share of gas. The commission, however, will not ask Congress for authority to exempt small producers because, according to Morgan, an exemption probably would result in price hikes by "minor producers . . . triggering escalation clauses in major contracts."

Now You've Heard Everything

A member of Desk and Derrick, in Washington attending the Republican Women's convention and getting acquainted with some Eastern women, got into a discussion about percentage depletion. One delegate asked the Desk and Derrick member exactly what it meant, saying that when she asked her congressman, he had told her that depletion was the oil that sloshed out of the tank cars and trucks when being hauled to market.

Isn't It?

"It's too bad future generations can't be here now to see the wonderful things we're doing with their money."

The Price of Cabbage

The San Diego Union has observed that:

"The Lord's Prayer has 56 words.
"Lincoln's Gettysburg address 266 words.
"The Ten Commandments have 297 words.
"Declaration of Independence has 300 words.
"Government order setting price of cabbage has 26,911 words."

— From The Standard Oiler

New BP Building in Paris

M. Hure, president of Societe Francaise des Petroles BP, recently laid the foundation stone for a new head office in Paris.

The new building will be approximately 165 ft high and will have 16 stories. A staff of 1200 is expected to occupy the office but accommodation will be available for 1500.

Photo below shows a model of building.

Good Wells Make Good News

Some Recent Frac Treatments That Gave Exceptional Results

December, 1961

Here are four recent examples of how Dowell engineers combined special materials and techniques with creative engineering to help operators get better than expected results:

- **Westmoreland County, Pennsylvania** (New Gas Well) Pay zones are the shallow Bradford and Tiona sands. Operator wanted to open more drainage area in this well than previous fracture treatments had opened in other wells in this area. He also wanted a decline rate slower than those of neighboring wells. Dowell designed a treatment using Waterfrac and high injection rates. First, the Bradford was fractured using 600 barrels gelled water and 28,000 pounds sand. Injection rate was 40 bpm at 2600 psi. Then, a wire line bridge plug was set and the Tiona was perforated and fractured. 700 barrels gelled water and 30,000 pounds sand were injected at 30 bpm and 2600 psi. *Before treatment, well produced 15,000 cfpd. 90 days after treatment, well was delivering 240,000 cfpd.*

- **Okfuskee County, Oklahoma** (New Oil Well) Pay is the lower Sonora sand at about 1230 feet. Other wells in the pool had been completed through conventional perforations and fractured with straight lease crude and 20-40 mesh sand. Production from these wells usually declined to about five bopd within two weeks. Frac sand also returned, causing pump repairs and cleanouts that often cost as much as $1000 per well. Dowell used Abrasijet® abrasive jetting service to cut notch at 1231 feet, then fractured using 5000 gallons lease crude with fluid loss control agent and 8000 pounds 10-20 mesh sand. *Well leveled off at 25 bopd and no sand troubles were encountered.*

- **Uintah County, Utah** (New Gas Well) This well is completed into a five-foot section of the Brushy Basin sand. Arasijet was used to cut two vertical notches in the casing between 7399 and 7402 feet. Dowell then fractured using water with a demulsifying agent added. First, 1000 gallons carried 250 pounds of sand and 10 gallons Freflo® to clean notches. Then 2000 gallons water without sand was injected as a spacer between sand and aluminum pellets to follow. The next 10,000 gallons carried 1470 pounds of aluminum pellets. Pellet concentration was increased during treatment from 0.02 to 0.20 pounds per gallon. Pressures during job ranged from 3600 to 4000 psi and injection rates varied from 31.0 to 11.5 bpm. Well made 1500 mcfd after treatment. *Other treatments in area using 20-40 sand as fracture prop had screened out.*

- **Midland County, West Texas** (Old Oil Well) This is a recompletion into the upper Devonian after the lower Devonian had been depleted. Production is from four sets of perforations between 11,504 and 11,646 feet. Dowell spearheaded Waterfrac with 3000 gallons BDA® breakdown acid. 60,000 gallons gelled water and 116,000 pounds sand were injected in two equal stages. 3000 gallons regular acid was injected between stages and 4000 gallons Retarded Acid injected after last stage. *After treatment, well flowed 946 bopd through a 3/8" choke. Well-head pressure was 1750 psi and gor was 2807.*

Ask your Dowell representative for suggestions about how to get better production from your wells. Dowell services and products are offered in North and South America, Europe, North Africa and Iran. Dowell, Tulsa 14, Oklahoma.

SERVICES FOR THE OIL & GAS INDUSTRY — DOWELL

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Oil Fuel Cell Coming?

The fuel oil business is in the midst of a technological revolution out of which may emerge whole new lines of oil burning equipment. Aden P. Williams, manager of fuel oil sales of Humble's marketing department, says the fuel oil industry is moving into a new phase of stepped-up development in oil heating equipment and is broadening use of oil in other appliances. He mentioned oil-powered miniature heaters, oil-burning instant hot water heaters, air conditioners, incinerators, and possibly clothes dryers, all powered by fuel oil.

Another item is the "Magic Grid" heat booster, which burns oil without smoke. During field testing, actual savings in fuel cost ranged from 9% to 40% with an average of 21%. Mr. Williams also notes a "future possibility of homes generating all their electric needs from an individual oil-fired turbine generator."

How Beneficial Are Fringes?

Fringe benefit costs have more than doubled during the 1960's arriving in 1961 at a total cost of $42 billion, according to U. S. News and World Report. The petroleum industry pays the most in fringe benefits, welfare plans costing $1 an hour, including paid leave and premium pay. Average cost for all industries is 47.5¢ an hour. This means that workers benefits that don't show up in pay envelopes are running up the cost of doing business faster than increases in regular pay. The question is: Would an employee take his pay in benefits if he had his choice?

USSR vs USA Engineers

Recent achievements and future goals of the Soviet Union in the field of engineering and engineering education and manpower utilization are presented in a report published by Engineers Joint Council, Inc. For instance, the USSR annually graduates approximately 117,000 engineers, compared to 38,000 for the United States, and Soviet plans call for substantial increases.

The report, "The Training, Placement and Utilization of Engineers and Technicians in the Soviet Union," is based on a tour of the Soviet Union made last year by six representatives of United States engineers sponsored by Engineers Joint Council with financial support of the National Science Foundation and under an exchange agreement between the USA and the USSR. The 112-page document is available for $1.00 from Engineers Joint Council, 29 West 39th Street, New York 18, New York.

"Grass next door may be a bit greener, but it's just as hard to cut."

Are We Mature?

Only as long as oil company managements exercise self-discipline and restraint will the industry enjoy a bright future. Fred H. Moore, recently named president of Mobil Oil Company, made this prediction before the New Mexico Petroleum Industries Committee. He noted that "maturity means developing the ability to cope with industry problems on the basis of reason rather than emotion."

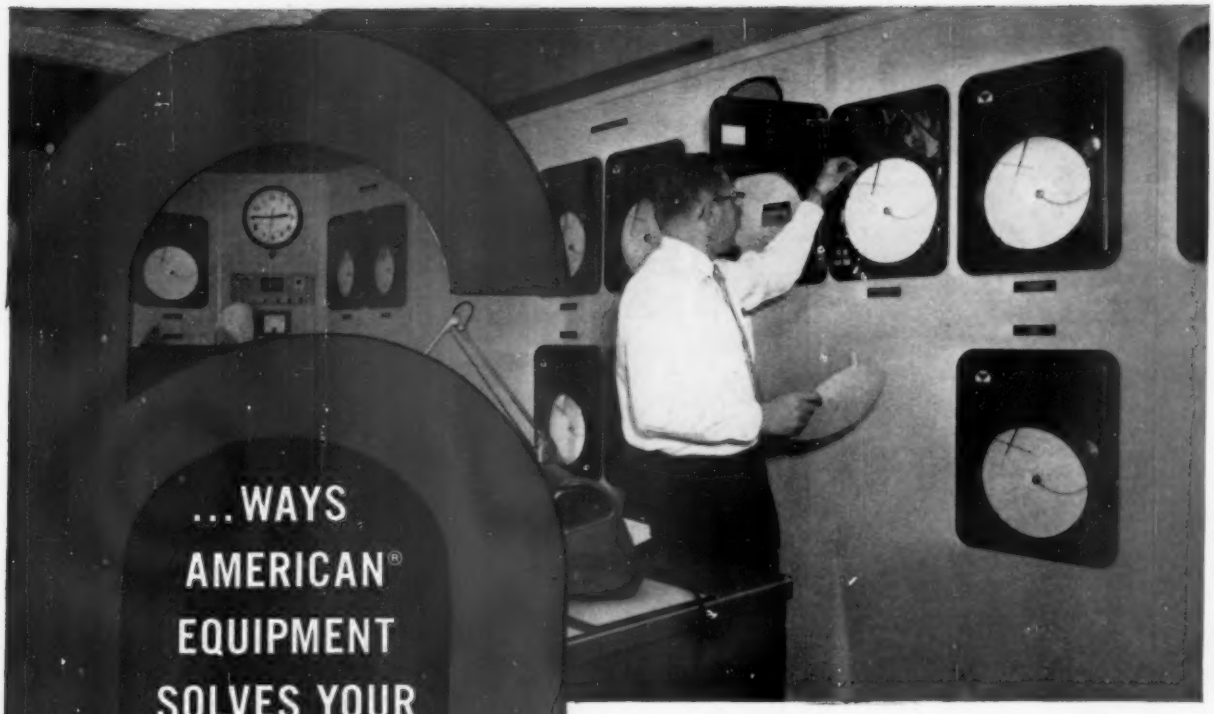
One of the signs of maturity he cited was the "corporate weight control" programs "which have done much to improve the health of an obese industry." The programs include cost reduction, reorganization, and establishment of better planning techniques throughout the industry.

"Other problems, such as overcapacity and pricing, are still with us," Mr. Moore said, "but I am hopeful that good judgment and restraint will help us solve these problems as well."

He emphasized the need to "improve our economic intelligence and our statistical procedures for gaging new trends. We must learn to live with some overcapacity. Our research and development programs must be expanded to develop new methods and ideas to lower our costs and improve our efficiency."

Merry Christmas!

A Christmas tree taken from a greeting card sent last year by L'Union des Chambres Syndicales de L'Industrie du Petrole, Paris, France.



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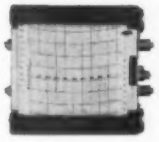

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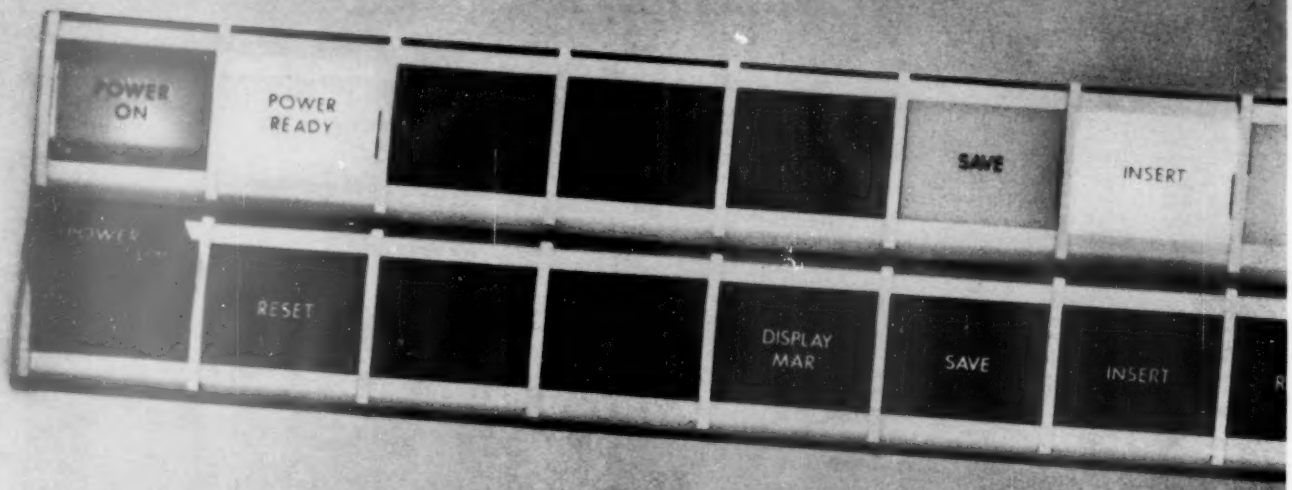

ype #3 PDQ Boiler [4 & 6 pt]

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0024 00400

0024

determined from diagram below

[3-3] [3-3] [1-4]

switch #1 switch #2 switch #3

rt with: 49 0887G

rom when switch #1 on calls for column #1

on " switch #n on " " #n

after next column pack Release & start:

Column #3 entered: Release & start

for entry of Δ_1 & Δ_2.

F after last number in Columns #1

-t or 7^9 to next set of columns:

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0887G switches.

THREE

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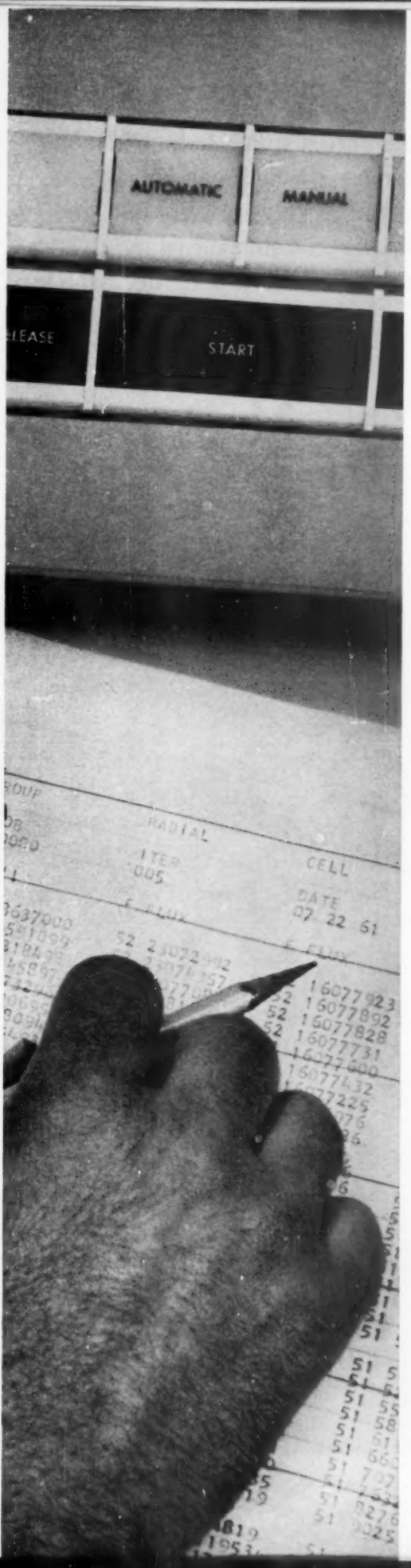


Cost of one-dimensional criticality computations drops from an average of $75.00 to $7.50 per problem

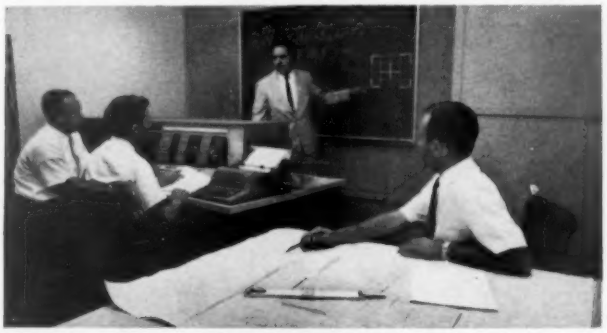
Faster computing, less travel time are the reasons why General Nuclear Engineering Corporation has realized such cost savings since it installed an IBM 1620 Data Processing System at its Dunedin, Florida plant.

Since its main computing facilities are not located at Dunedin, General Nuclear has found that the new 1620 eliminates much of the travel time and expense involved in taking problems to off-site computers. In addition, the 1620 performs the simpler criticality computations 10 times faster than the computer previously used at one of General Nuclear's off-site data processing centers.

General Nuclear uses its new 1620 for other problems, too...heat transfer calculations, various transient codes, mathematical routines for the physics and engineering departments, multi-group calculations, and many other jobs you might expect only a much more expensive computer to be able to handle.

This isn't all. General Nuclear uses the 1620 to do statistical analyses and variance calculations on input data for programs run on off-site large-scale IBM computers.

For information on this highly versatile, low-cost data processing system, which rents for as little as $1600 a month, contact your local IBM Representative.



Easy to program. FORTRAN, IBM's scientific computer language is available for the 1620. General Nuclear scientists use a special scientific interpretive program—FIDO—written by the Manager of their Computing Section.

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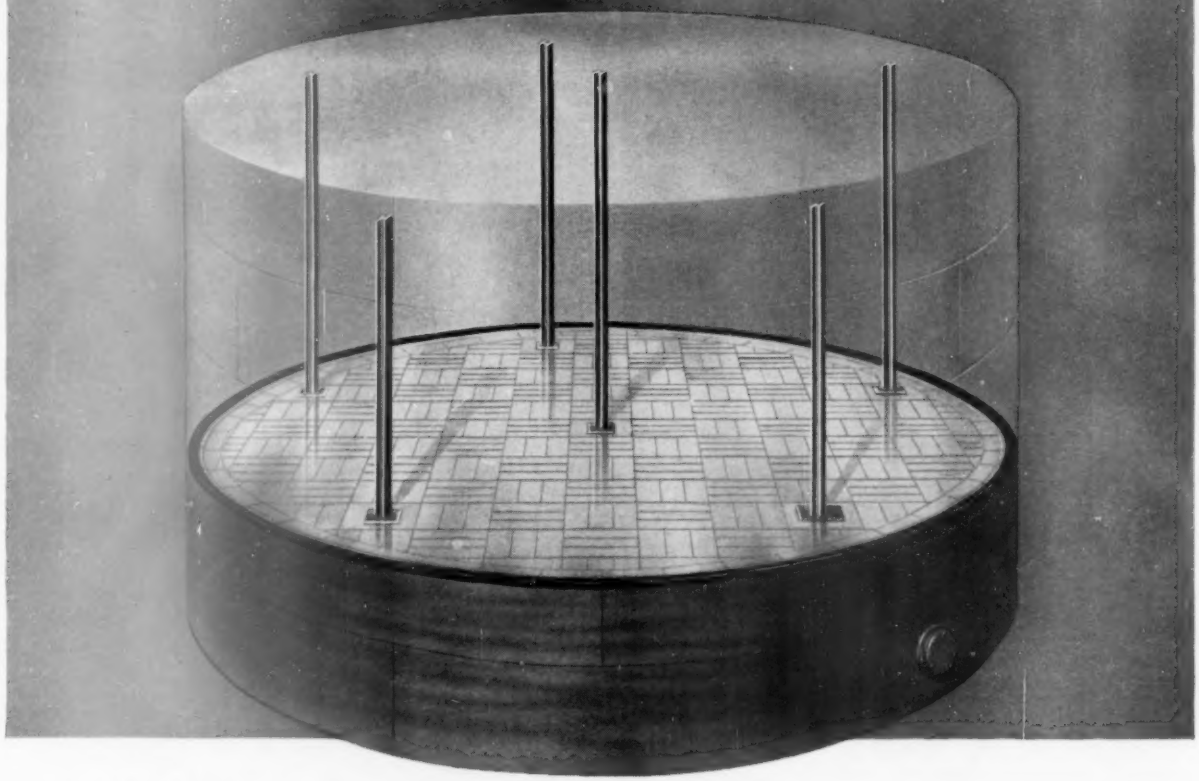

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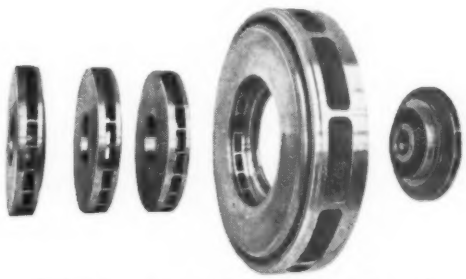
How Solar gas turbine compressor sets with interchangeable stages offer users low cost, versatility

The advent of Solar gas turbine-powered centrifugal compressors is ending the long-time dependence on reciprocating power for the low volume gas compression range under 1600 inlet scfm.

It has long been known that a centrifugal compressor would be less expensive to own and operate in this range if an efficient, long-life driver were available.

The introduction by Solar of an industrial gas turbine driver in the small horsepower range has resulted in a centrifugal compressor unit which has the advantages of low installation and maintenance costs as well as versatility and portability.

Through use of a concept of interchangeable staging, operators of Solar compressor sets have at their fingertips an almost infinite capability to meet changing flows and pressures—within the conditions of 1.15 to 3 ratios, 200 to 2000 hp and 200 to 1600 inlet cfm. This is accomplished by a set of five pre-engineered compressor wheels—A through E—each of which has a choice of three different guide vanes and a diaphragm. By selection of these 25 basic parts—five wheels, fifteen guide vanes, five diaphragms—any flow and pressure in the low volume range can be met quickly and easily.



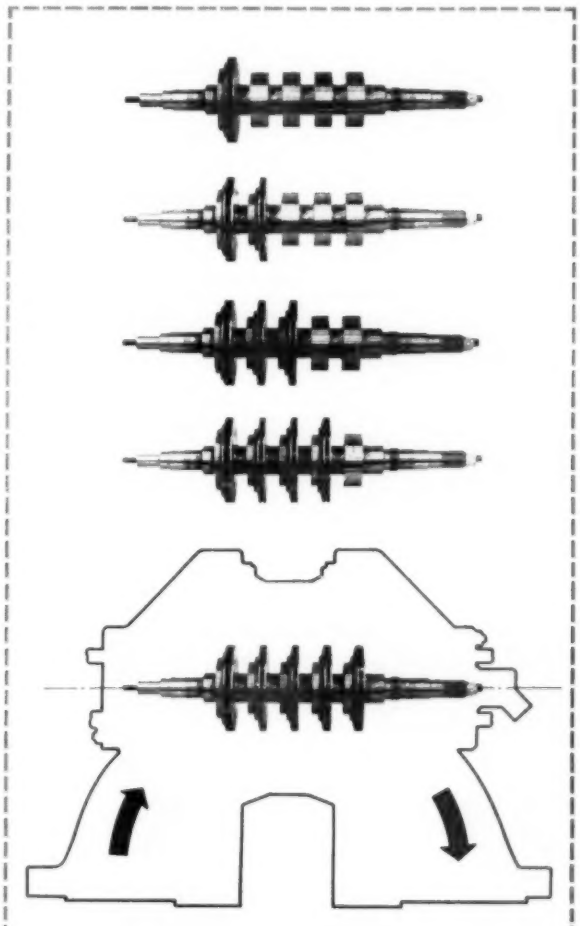
Each of 5 compressor wheels (right) may be used with diaphragm (center) and choice of 3 guide vanes (left) to meet any pressure, flow requirements.

For instance, to meet a certain set of conditions, two "B" wheels and a "C" wheel with specified guide vane configurations might be prescribed. When these conditions change, a new setup requiring one "B" wheel, one "C" wheel and one "D" wheel might be necessary, again with the specified guide vane configurations.

All that is required to meet the change is substitution of new wheels in the same compressor on the same shaft in the same axial space—an operation which can be done easily and quickly on site. And all wheels, guide vanes and diaphragms are available for instant delivery from Solar's pre-engineered, on-the-shelf stock.

Solar 1100 hp *Saturn* turbine-driven compressor sets weigh 15,000 lbs—approximately ⅒th the weight of comparable reciprocating machinery. They occupy less than 300 cubic feet. These factors mean they are less expensive to install and easily portable to a new site for periodic maintenance.

They are currently in service in several pipeline and field boosting applications. For more information, write to Solar, Dept. J-175, San Diego 12, California.



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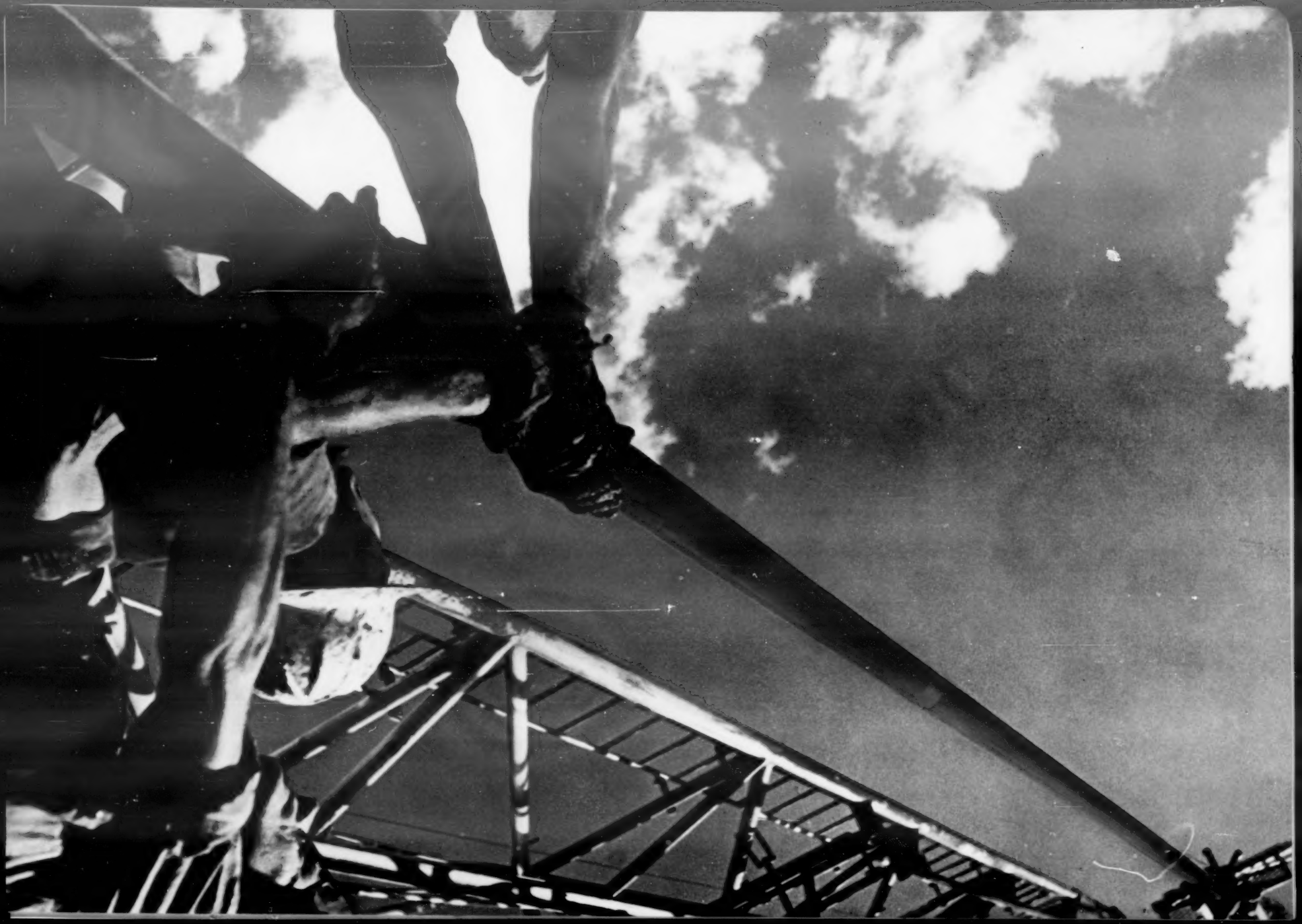

TUBING

Standardize on low cost Buttress joints for special tubing clearance problems

Take away the upset. Redesign the threads. Tin coat the coupling threads. Then ring with the bright Orange Bands of Youngstown so everyone in the Oil Country will recognize the unique high quality of a new low cost Buttress Thread Tubing.

Here's non-upset tubing with joint strength comparable to the strength of upset tubing—with tin-lubricated threads to provide tight, leakless seals that make up again and again without galling. Here is a brand new addition to Youngstown's complete line of quality oil country tubular goods.

Specify Youngstown Buttress Thread Tubing 2⅜" and 2⅞" in Grades J-55 and N-80 with regular or special clearance couplings. Get fast, on-time delivery wherever you are from Youngstown in-transit and mill stocks. Get help to use it from the largest field engineering staff in the Oil Country. Get high strength with improved clearance at no extra cost over A.P.I. external upset tubing. Order new Buttress Thread Tubing from Youngstown.

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For full details on Youngstown Buttress Thread Tubing write: Dept. 2E,
The Youngstown Sheet and Tube Company, Youngstown, Ohio

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"Libyans – at all levels and in all parts of the country – have shown their willingness to join in the work of making their nation a significant oil producer. We in Jersey have been fortunate to be associated with such people in the big job of bringing Libyan oil to world markets."

–M. J. Rathbone, President

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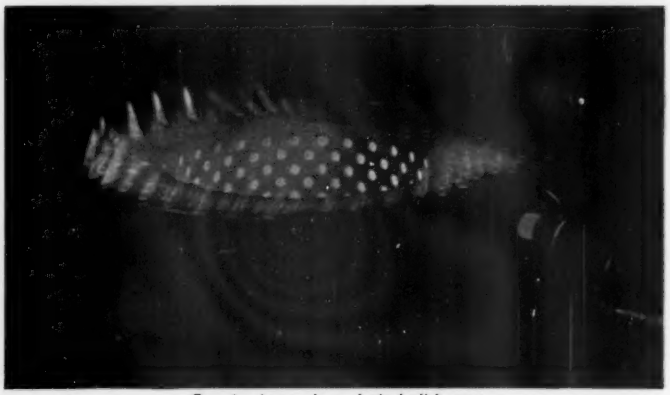


Circular-type, air-aspirated oil burner

These new burners from the Gulf Oil Corporation aspirate and atomize fuel for clean burning at firing rates as low as 0.005 gph. In doing so, they offer new versatility in shape and size for a host of new product uses

GULF

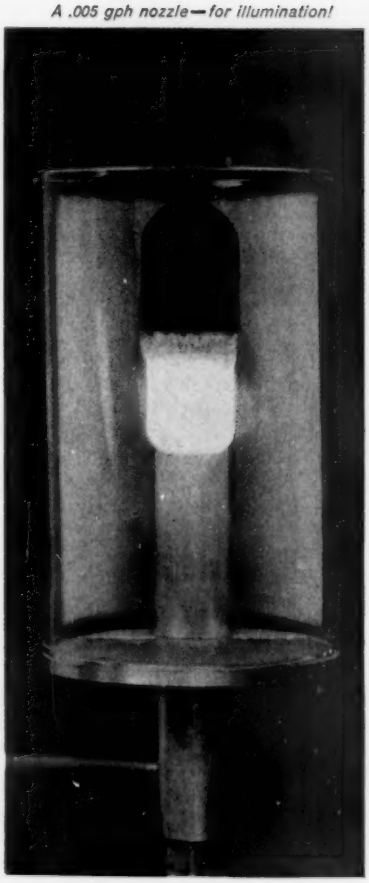
Here is a remarkable, new kind of oil burner so compact and clean-burning it opens a whole new field of product advances and new product applications.

New concept in oil burners. In the quest for improved oil-burning equipment, Gulf scientists at Gulf's Harmarville Research Center developed this air-aspirated oil burner of amazing versatility and capacity.

Inside the nozzle, which operates at only 3 psi pressure, air and oil are thoroughly mixed before combustion. Result: cleaner, more efficient burning — and far less need for servicing.

Minimizes nozzle clogging. The large oil passages in Gulf's new nozzle practically eliminate nozzle clogging. They're up to 12 times larger than the passages in a conventional 100 psi pressure nozzle. The orifice is about 38 times larger!

A .005 gph nozzle—for illumination!



Still greater efficiency is achieved because there is no dribbling of fuel, either at start or shut-down. The nozzle temperature remains relatively low because it is cooled by air blown through it. This reduces the possibility of oil deterioration resulting from high nozzle temperature. In addition, there is no need for a combustion chamber!

Extraordinary nozzle capacities. Today's gun-type burners have usually been limited to about 0.65 gph for high-pressure burners, about 0.4 gph for low-pressure types. Below these, capacity nozzle clogging becomes particularly acute.

Gulf's new aspirating nozzle, on the other hand, offers you capacities undreamed of just a few years ago.

In the size used to power an ordinary illuminating mantle, for example, it fires at only .005 gph!

This is an unusual application, of course. But it does indicate how small a firing rate you can use with the new Gulf nozzle.

More usual capacities are 0.10, 0.25, 0.50, 0.75 and 1.0 gph. The nozzle can be used in multiple units, too, when a heat release of over 1 gph is needed!

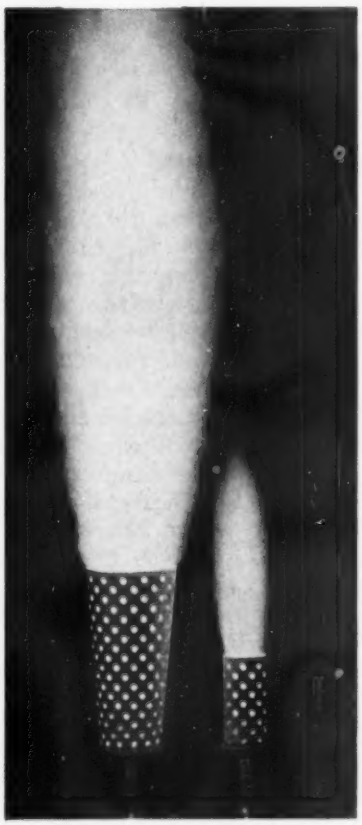
An air-aspirated oil burner—to order. You can construct an air-aspirated oil burner in an amazing number of versions.

To replace gun-type oil burners and gas burners in existing equipment, for example... quickly and easily.

Or for use in new equipment.

Or even in equipment for which fuel oil has never before been practicable!

It can be a vertical burner for use in a water heater. It can be a horizontal burner for use in a hot water boiler or warm-air furnace. It can be a circular model for a unit heater. It can simply be a nozzle fired into a perforated flame holder, for use, let's say, in a domestic clothes dryer or domestic incinerator.



Unusual capacities—1.0 to 0.1 gph

Horizontal-type, air-aspirated oil burner in a triple-unit configuration

Similar units can be combined to attain varying Btu inputs. For example, three horizontal units of 0.18 gph each, to match the 75,000 Btu input of a three-section warm air furnace. The possibilities are almost limitless.

An old flame with new ideas. Truly unique, Gulf's air-aspirated oil burner can be made to replace gas-fired units in furnaces, boilers, water heaters and other equipment already in production.

This simplified oil burner can be adapted to entirely new applications, too—air conditioners, incinerators, dishwashers and clothes dryers, to name a few.

Indeed, the air-aspirated oil burner promises many new product advances, as well as a widely expanded use of fuel oil.

Like more information? Gulf is not in the business of manufacturing oil burners or any kind of oil-heating equipment. We make these developments available to oil-heating-equipment manufacturers on a Royalty Free — Non-Exclusive License basis.

If you would like further information about how you can adapt Gulf's air-aspirated oil burner to your product and equipment needs, simply contact Gulf Research and Development Company, P.O. Box 2038, Pittsburgh 30, Pennsylvania.

Vertical-type, air-aspirated oil burner

by R. K. Nemitz

Natural Gas Invades Europe's Energy Market

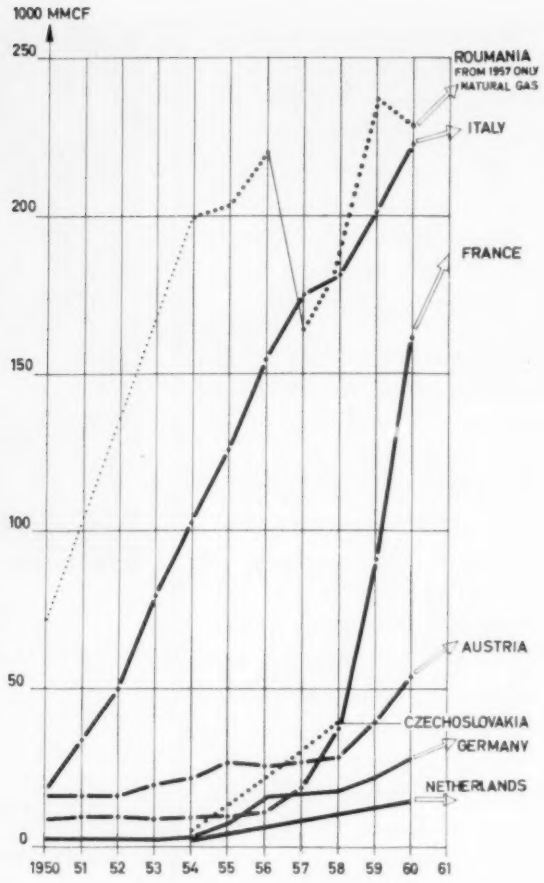


Fig. 1. Natural gas production

Natural gas has added to Europe's energy sources of coal and petroleum in recent years. With rising production figures, this third source of energy is capturing large portions of the market. Natural gas helps meet part of the growth in energy consumption and it also supplies new industrial needs, such as petrochemistry.

Energy consumption in the 17 OEEC (Organization for European Economic Cooperation, now taken over by Organization for Economic Cooperation and Development) countries rose 1950 through 1959 by nearly 35% up to 824 millions of tons of hard coal equivalents. In the same period, the share of natural gas soared from 0.7 to 13.6 million tons of hard coal equivalents. This represents the greatest rate of growth among all primary energy sources. Rate of increase in natural gas production has varied in different countries (Table 1 and Fig. 1). Table 2 indicates the rise in energy demand in European economic bodies and countries that have a domestic gas production. Further development was predicted by the OEEC early in 1960 (Table 3).

Let's take a look at natural gas in specific areas of West European countries, of the Communist areas and of North Africa.

West Germany

With an output of six million tons per year, West Germany ranks first in oil production among West European countries, but the search for natural gas has not yielded any comparable results. Due to importance as a domestic energy source and the abruptly rising power demand, a vigorous exploration program is now going on.

The first gas field was discovered in Germany in 1910, south of Hamburg, when a well was drilled for water. This find and a second made in 1938 were only a modest start in natural gas production until recently when more substantial deposits were found. Germany's natural gas lies in three geological basins, where the important oil fields are also situated (Fig. 2). The North German Basin, extending westward into Holland, consists of sediments of considerable thickness ranging from Upper Permian to Tertiary. Here, at depths of 4920 to 13,120 ft, the largest German gas fields were discovered, partly in sandstone, partly in cavernous lime of dolomite. This gas contains up to 20% hydrogen sulfide. Among 14 fields of this area, Rheden, with 4.5 billion cu ft a year, is largest.

The large Tertiary trough on the northern

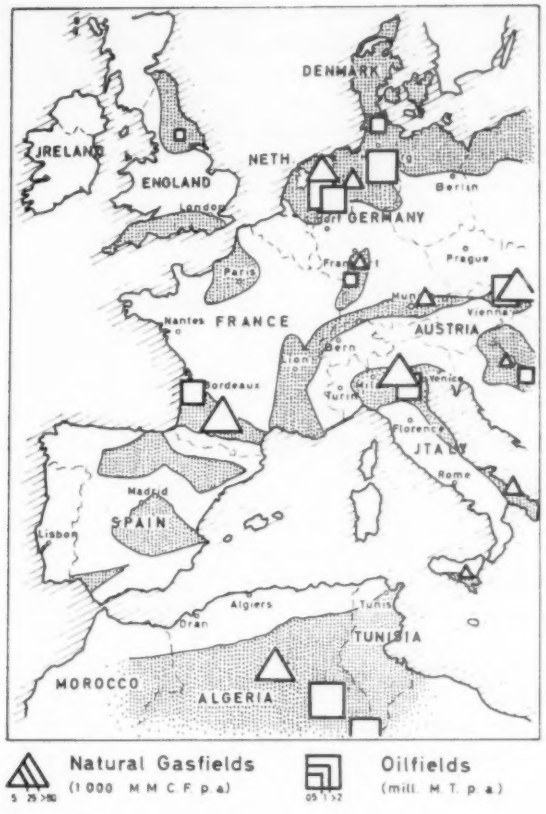


Fig. 2. Sedimentary areas in Europe.

Fig. 3. Natural gas systems in Europe

rim of the Alps is the second basin. Seven gas fields have been found there. Reserves of this district are estimated at 140 to 175 billion cu ft. In the Upper Rhine Valley (Graben), several minor gas deposits were tapped. For the most part, the gas is produced from unconsolidated fine shaley sands at shallow depths only. Experiments are still being carried on to find a solution of the sand problem.

Natural gas reserves in Germany are estimated at 875 to 1050 billion cu ft. Thirty natural gas fields were developed in 1960 and 21 put in production. Output amounted to about 15.75 billion cu ft.

Table 1. Natural Gas Production in Europe.
(Billions cubic feet)

Year	Germany	Italy	France	Austria	Neth.	Yugo-slavia	Romania
1950	3	18	9	16	0.3	0.5	70
1951	3	33	10	17	0.3	0.5	...
1952	3	49	10	17	0.6	0.5	...
1953	3	79	9	19	1	3	...
1954	5	102	9	22	3	3	200
1955	11	125	10	27	5	2	203
1956	16	154	12	26	6	2	221
1957	16	175	19	27	7	1	161
1958	16	181	37	29	9	2	179
1959	19	214	92	39	11	2	238
1960	23	222	159	51	...	2	228

This is below capacity but markets are insufficiently developed. Production will be spurred considerably by expansion of pipeline systems and building of power stations and petrochemical plants. The overall gas-line network in Germany extends more than 41,000 miles (Fig. 3) but consists mainly of distribution lines for coke-oven and town-gas. Natural gas lines are of regional significance only.

The part natural gas plays in the German energy market, is still insignificant. The share of natural gas in the total gas output was only 2.5% in 1960. A production increase, however, appears inevitable.

Austria

Natural gas was first found in Austria about 1900 and other fields were added in the thirties but they did not result in any substantial production. Today, the most important natural gas deposits are in the Vienna Basin (Fig. 2) where strata up to 1524 ft thick were found. In the period after World War II a total of 11 fields were developed. In some places the production is from gas caps of saturated oil reservoirs. The

biggest natural gas field was discovered in 1952 at Zwerndorf (Vienna Basin) near the Czechoslovak border when Austria was still occupied by the Russians. Drilling the first hole resulted in a wild gas blowout which could not be controlled for two years. As the field also extends into Czechoslovak territory, joint agreements as to the production were made. Reserves recoverable by 20 production wells are estimated at 700 billion cu ft, of which more than 385 billion cu ft belong to Austria.

In Matzen field natural gas has been produced from shallow depths of 1640 to 2624 ft, some 3280 ft above the oil reservoir. Reserves are from 70 to 105 billion cu ft. Other fields are small. Total reserves are some 875 billion cu ft.

Austrian natural gas is mainly used for Vienna electric power stations and gasworks; recently it also supplies some major industrial plants. In 1960, 50% was used for public energy supply; 38% by industry, and the oil industry's own consumption accounted for less than 10%.

Natural gas is transported to the consumers by long-distance pipelines. The pipeline network of the country is being expanded (Fig. 3).

In Austria special emphasis is placed on natural gas since it replaces coal, which must be imported. The natural gas share of total energy output is more than 15%.

France

Discoveries in recent years have made France the fastest growing natural gas producer.

Several basins in France offer favorable geological conditions for gas accumulations, only one of which, however, (as in Italy or Germany) is situated close to the center of heavy industry (Fig. 2). In the Basin of Paris exploration activity led only to minor oil finds.

Gas deposits in the Aquitaine Basin on the north rim of the Pyrenees were discovered in 1939. Tectonic stresses exerted in later periods have created a number of faults and uplifts in the basin. In 1957, 70% of the total French natural gas output was produced from the field of St. Marcet. The best wells of the field yield more than 35 million cu ft of gas per day.

The great reservoir of Lacq was discovered in 1951 when an oil well was deepened. It has a reserve of more than 7 trillion cubic feet, the most important natural gas field of Europe. The deposits are in a cavernous limestone at a depth of 9840 to 14,800 ft. The gas is 75% methane and higher hydrocarbons, 16% H_2S and 9% carbonic acid. Reserves of methane amount to 3.85 trillion cu ft. To produce and utilize the gas, novel problems had to be solved on account of its chemical composition. A corrosion-resistant steel was necessary since the high sulfur content had extremely corrosive effects. Furthermore, special safety measures had to be developed to protect men near production facilities from the danger of poisoning.

At first development of the field limped along. In 1958, six wells were in production with a daily yield of some 42,000 Mcf. With 30 more wells production will be increased to 1.05 billion cu ft per day. Recovery of sulfur will grow from 200 to 3000 t/d, as much as the total sulfur consumption of Western Europe. The recovery process is fully automatic and remotely controlled to reduce danger to a minimum.

Due to development of the Lacq production, France will in 1962 recover more than 245 billion cu ft. The gas, far from consumer centers, has to be conveyed in long carrier pipelines. In 1942, a gas line from St. Marcet to Toulouse was opened. Later Paris and Lyon were connected with the Lacq field by transmission lines (Fig. 3) although Lacq gas also created a great boom for regional industry.

For seasonal fluctuations in gas consumption an underground storage cavern with a capacity of 70 billion cu ft was built.

France likewise follows the trends of increase in energy demand and a shifting from coal to oil and natural gas. Efforts are being made to avoid too great an expansion of the market area to reserve gas supplies for long term contracts.

Due to the upward trend of gas production, petrochemistry is experiencing a remarkable

Table 2. Development of Energy Demand and Share of Natural Gas in Europe.

	Europe	Energy consumption —million tons HCE*—			Increase % 1950–1960	Share of natural gas % —energy consumption—			Per capita energy consumption —tons HCE*—			Natural gas reserves† billions CF
		1950	1959	1960++		1950	1959	1960	1950	1959	1960++	1960
Economic Bodies	OEEC	614.2	823.8	—	—	—	2	—	2.0	2.5	—	—
	EFTA	291.3	340.1	—	—	—	—	—	3.4	3.8	—	—
	EWG	296.3	440.7	465.0	57	—	3	3	1.9	2.6	2.8	—
Countries	Germany(West)	128.9	190.8	216.4	68	—	0.5	1	2.6	3.5	3.9	875
	Austria	9.5	15.0	16	68	4	10	11	1.4	2.1	2.3	875
	Italy	27.8	61.1	66.4	139	2	13	12	0.6	1.2	1.4	4550
	France	85.3	120.4	132	55	—	3	3	2.0	2.7	2.9	7350
	Netherlands	22.1	30.1	33	49	1	1	1	2.2	2.7	3.0	2450

† Figures on account of different calculation methods not direct comparable. The data represent orders of magnitude only.
++ Figures partially estimated. * HCE — Hard coal equivalents.

boom. In the immediate surroundings of Lacq one of the biggest petrochemical industry centers in France is rising.

North Africa

The first oil find in the French Sahara was made 620 miles south of the Mediterranean Coast at Edjele, near the Libyan border. The great Hassi Messaoud field, 250 miles northward, was discovered in 1957. Here along with the oil, big amounts of gas are recovered. Presently, about 10.5 billion cu ft of gas is flared per year. The scheduled increase in production will push this volume to 35 billion cu ft. Gas reserves of the field amount to nearly 3500 billion cu ft.

Also the natural gas field of Hassi R'Mel was discovered in 1957 some 280 miles south of the town of Algiers. This field has not yet been fully developed, but tests show it is one of the largest natural gas reservoirs in the world with reserves of more than 28 trillion cu ft. Production potential of the Sahara can soon be 595 to 1400 billion cu ft per year.

In spite of political tensions in Algeria, work is carried on. A pipeline was laid from Hassi R'Mel to the Mediterranean Coast to supply the towns of Algiers and Oran with gas (Fig. 4). But even after completion of the new industrial plants (steel works of Bone) it is estimated natural gas consumption in the whole of Algeria will reach a maximum of only 140-175 billion cu ft. Thus Algeria will be increasingly an exporter of energy to Europe if transport problems can be solved economically.

Italy

Presently the most important natural gas producer of western Europe is Italy. From some 35 gas fields were produced in excess of 220 billion cu ft in 1960. This corresponds to nearly 50% of the total West European production.

The first gas find was made in the Po Valley in 1932. From this time on, especially in the period 1950 through 1956, one discovery followed the other. After World War II a state-owned company took over and through subsidiaries work was carried out in accordance with the latest American methods, learned in training centers staffed for a period with American instructors.

Italy's natural gas deposits are situated in three geologic basins: In the Po Valley, in Apulia, and in Sicily (Fig. 2). Some highly folded subsurface rocks of the Po Valley contain gas reservoirs at depths ranging from 1640 to 11,480 ft. Thickness of the mostly unconsolidated sands varies from 33 to 330 ft.

In a Sicilian sedimentary basin of younger geologic age, near the town of Catania, and in Apulia, near Ferrandina, several gas fields, of minor importance, were discovered.

A decree issued by the Italian Government January 1, 1961 ordered production of natural gas in the Po delta (which had yielded some 122.5 billion cu ft) stopped completely. Survey data indicated that gas withdrawal had caused sinking of the ground level by 7⅜ in. to 11¾ in. during the last 70 years. This condition increased the danger of inundation.

Total gas reserves of Italy are estimated at approximately 4.55 trillion cubic feet. This energy source — a significant factor for Italy — is channeled into a variety of industrial plants. Through a pipeline grid of more than 3700 miles in the Po Valley 560,000 to 700,000 Mcf are daily conveyed from gas fields to consumers (Fig. 3), among which are the city of Milano, the chemical industry of the surrounding region, and the Fiat plants in Turin. In 1959, 85% of the output went to industry. In Italy natural gas resources are fortunately located near industry.

Conversion from coal (which must be imported) to natural gas is steadily growing. An annual balance of the Italian power economy shows that the share of natural gas in meeting the demand has risen from 0.1% in 1938 to 12% in 1960. For the years to come, however, the rate of growth in natural gas production may soon reach its limit.

Table 3. Energy Balance of OEEC† Countries.

Energy production	1955	Million tons HCE* 1965		1975	
		OEEC	Import	OEEC	Import
Coal	477	440-480	10-60	430-495	10-6
Lignite	30	45	—	60	—
Crude oil	13	30	260-310	50	380-500
Natural gas	7	25	5	50-60	10-75
Water power	56	90	—	140	—
Atomic energy	—	15-20	—	30-90	—
Others	20	20	—	20	—
Total	603	670-715	174	780-915	400-635
	777	945-1090		1180-1550	

† Organization of European Economic Cooperation (West Europe).
* HCE = Hard coal equivalents.

The Netherlands

The Netherlands has become a natural gas producer in the last year. A wildcat in the north province of Groningen, discovered an extensive gas field. Preliminary estimates of reserves amount to at least 2.1 trillion cu ft. Unofficially, however, higher figures are mentioned. At present, this Zechstein reservoir, (Upper Permian, located at a depth of 9,840 to 13,120 ft) is being outlined by wells drilled toward the German border and also into the open sea. The drilling platform of NAM "Triton" (constructed in

Wallsend-On-Tyne, England) is working about 2.5 miles off the coast. This first off-shore location in Europe is scheduled to explore along the Netherlands coast to a depth of 6560 ft.

The same geological basin in which the new gas reservoir is situated extends to the German side where remarkable gas finds were made.

In Holland drilling activity was highly intensified after World War II leading in the period 1948 through 1952 to the discovery of five natural gas fields in structural uplifts. Total natural gas reserves developed up to 1959 were in the neighborhood of 140 billion cu ft. Although small, this reserve was a significant factor in the power economy of the country. Gas is scheduled for production at an annual rate of about 8.75 billion cu ft, gradually rising to 19.15 billion. The new reserves will lead to a revision of the energy economy of the country and may also influence the energy policy of neighboring countries, especially Belgium and Germany.

Communist Countries

In the Soviet Union natural gas production from 1951 to 1960 increased by more than 1.4 trillion to some 1.64 trillion cu ft per annum. Production of the Ukraine has doubled in this period. Of this output 75% goes to industry and 25% to households. A further increase will depend on expansion of the pipeline network. Of Moscow's energy needs 80% is now met by natural gas from the Black Sea to the capital in a 932-mile transmission line.

Most important gas producer in East Europe is Romania. In recent years separation of gas from vast oil fields and output of natural gas from old gas fields have steadily increased. Romania's gas production is ahead of Italy and France, exceeding 175 billion cu ft in 1953 and reaching 238 billion in 1959.

Natural gas reserves of Yugoslavia are reported to be about 70 billion cu ft. The first field was discovered in 1918. Annual production of the seven fields developed to date amounts to approximately 1.8 billion, 50% of which is used by industry and the other 50% required for crude oil production.

Outlook

Overall European natural gas production has increased tenfold in the last decade. This rise shows the intensive efforts made to develop the gas reserves of the continent and put them to commercial use. If plans to transport Saharan gas are successful enormous energy reserves will be at the disposal of Europe and industry. Although one experiment is being made to use natural gas instead of coke in blast furnaces in Algeria this will not lead to industrial application on a large scale in that country.

Many schemes to transmit Sahara gas to Europe are under study. Here are some of them:

1. Transport through pipelines (Fig. 3). Plans are to lay several long distance lines via Gibraltar or Sicily. According to preliminary calculations the cost of transporting Saharan gas to France or to Germany may be about $0.006/cu ft.

2. Converting natural gas to electric energy. Generation of electric energy by natural gas is uneconomic if gas reservoirs are minor or if demand is small. For Saharan gas the idea is of interest since reserves are immense and demand would be high. High voltage direct currents could be transmitted by long submarine power cables.

3. Tanker transport of liquefied natural gas. Liquefying and vaporizing the gas is expensive, but the procedure does not raise technical difficulties. Insulation of the ships is costly since the temperature of liquefaction of minus 234 F must be maintained. About one average tanker load (15,000 tons of liquefied gas) corresponds to a town gas volume of about 1.26 billion cu ft. The first experiment to transport 2000 tons of liquefied natural gas from America to England was successfully carried out last year. Great Britain has now decided to build two large capacity tankers for natural gas transport from the Sahara. For this purpose a contract for annual delivery of 35 billion cu ft was signed.

It remains to be seen in which way the problem of supplying energy from the Sahara will be solved.

One thing, however, is sure — natural gas will within a few years be an important energy source in most European countries.

About the Author

R. K. Nemitz is assistant to the chairman of the board of Deutsche Erdol-Aktiengesellschaft, Hamburg, Germany. After passing the examination for certified mining engineer at the Technical Academy of Aachen he joined DEA and underwent a one-year training period. After that he served two years, 1957 to 1959, as plant engineer in a refinery. He was then appointed superintendent of DEA's oil and gas fields in the Upper Rhine Valley. In 1960 he was promoted to his present position. He spent several months in 1961 visiting operations and studying the petroleum industry of USA and Canada. ■

University of Texas Professors F. A. Matsen (standing left) and R. Pettit (standing right) confer with Humble employees Ewell Brigham, Ovide Webber, W. J. Farrissey and Nugent F. Chamberlain (left to right) during the 100th course in Humble Lectures.

Lectures in Science

Technical obsolescence of manpower is a problem as real to modern industry as outmoded tools and equipment. Skills grow rusty; techniques become obsolete. Today's petroleum scientist is hard put to keep in contact with the fundamentals of his field of study once he leaves the university campus.

A research manager put it this way recently: "We find that by the time a man becomes a good oil chemist, he is no longer a chemist in the broad sense of the word."

One solution to this, oil companies have found, is periodically to send the scientist back to the halls of ivy. As another answer, the Humble Company brings prominent educators to its Baytown (Texas) Research Center to present short courses in basic science subjects.

This program, which in effect brings the university to the man, is called the Humble Lectures in Science and Engineering. For 15 years, it has provided Baytown refinery's technical task force an unusual opportunity to stay abreast of developments in the ever-changing world of science and engineering.

This fall, the 100th lecture course in the series was conducted by two University of Texas professors on theoretical organic chemistry. Dr. F. A. Matsen was one of Baytown's first lecturers back in 1946 and since that time has conducted five courses — more than any other professor. This noted theorist in chemistry and physics will be assisted by Dr. Rowland Pettit, brilliant Australian chemist who, like Dr. Matsen, is a consultant for Humble.

Up to the century course, Humble has offered graduate level courses to its chemists, physicists, mathematicians, and engineers, led by 77 professors from 38 colleges and universities in 16 states and four foreign countries. Eminent scientists all, these professors are known and respected around the world.

Take Dr. Linus C. Pauling of California Institute of Technology, who lectured at Baytown in 1951 on the nature of the chemical bond. He won the 1954 Nobel Prize in chemistry for unlocking some of the age-old mystery of what holds the atom together.

Dr. Willard F. Libby, former member of the Atomic Energy Commission and professor at UCLA, taught a course for Humble just last year. His 1960 Nobel Prize in chemistry was for perfecting the radio-carbon dating process.

Two other visiting professors — Sir C. K. Ingold of the University of London, and Sir Hugh S. Taylor of Princeton — were knighted by Queen Elizabeth for scientific accomplishments.

Five to eight courses, with men like these at the lectern, are scheduled at Baytown each year. Subjects range from the simple-sounding, such as "Mixing," to tongue-tanglers like "thermodynamics of nonelectrolytic solutions." The typical lecture originates and proceeds something like this: first, the 350 technical people are polled as to subjects desired. Then an outstanding professor is chosen in that field and invited to the research center for, usually, two weeks. These are not courses in refining technology nor refresher classes. They are fundamental science and engineering courses.

The guest professor exercises full freedom in selecting and presenting his material. Class size is small, from 9 to 16 persons, creating an atmosphere of informality and close association between the lecturer and student. Courses are conducted at company expense during the working day and class members are assigned to them full time for the two-week period.

Enrollment is strictly voluntary, but the vast majority of Baytown scientists take a course, on the average, every two years. Each course represents about a semester of graduate study, so the classroom pace is full speed ahead. ■

by Robley D. Stevens

Merit Rating the Engineer

A systematic merit-rating program gives management information essential to high engineering quality and performance. A good way to improve efficiency and economy of operation is by assisting the engineer to achieve his highest potential usefulness. It will serve a twofold purpose: (1) it gives a clear picture of where each engineer stands, either above or below par and (2) it affords a factual and non-emotional basis for discussing an engineer's good or weak points with him so he can up-grade his professional performance.

Jephthah used a merit-rating test. He wanted to distinguish his own men from the Ephraimites. He knew that his men were able to pronounce the sound "sh" but that the enemy could not. By requiring each man to pronounce "shibboleth" he was able to screen out those Ephraimites who tried to go through his lines. This type of merit-rating test served Jephthah's purpose.

Engineer's Job Essential

There is something about the nature of the engineer's job that is special — his job is different from other employees. In a way, his job is an essential of achievement, through improved performance. And since the engineer is a human being with all the qualities and variabilities of a human being, merit rating can insure fair treatment and recognition for his accomplishments.

Today studies indicate that employers generally look for these qualifications in engineers: Self-confidence; Sound judgment in carrying out professional work; Good working habits; Knowledge and skill; cooperative with superiors and other employees; makes suggestions for work improvement; active and energetic; dependable; can take criticism; level-headed; gets along well with other employees, and amenable to changes.

Don't hope for a simple method of merit rating the engineer. No simple method with a high degree of validity has been developed. Furthermore, the importance of the engineer's job justifies management using more extensive methods.

Gage Responsibility Capacity

One task in merit rating the engineer is to gage the effect on a professional person of assuming greater or different types of responsibilities. In a try out, some engineers improve; some display professional abilities not suspected; others are timid and inhibited. Those engineers with ability and desire for more responsibility grow with their new duties; those already at the limit of their ability may become fearful when assigned to more demanding tasks.

Merit rating the engineer for performance and potential for higher positions is a frequently used method. When well done, it can be an effective evaluation. It is an incentive to the engineer to do a better job in his present work.

Elements of a merit-rating program include an analysis of the duties, responsibilities, and needed qualifications, both professional and managerial. This involves a statement of requirements against which the engineer is to be measured. Your company must know what the engineer does and what the job requires before any rating can be made.

Clues to Look For

How do you begin merit rating?

Based on job analysis and study of professionals and engineers, the following list of tentative clues, taken together, may be helpful in identifying the potentials of an engineer:

Ask These Questions

1. Is he willing to explain his work to laymen?
2. Is he skilled at this task?
3. How effectively does he work with laymen?
4. Is he impatient about having his work reviewed by persons in other fields?
5. How does he respond to constructive criticism?
6. What is his verbal ability?
7. Does he have broad interests?
8. Is he interested in other fields of knowledge?
9. Does he respect other people's ideas in his own profession?
10. Does he have any respect for administrative considerations, such as the objectives of the users of his results?
11. Is he effective at sizing up people?
12. Is he more gregarious than those in his profession?
13. Does he pay attention to such amenities as exchanging pleasantries with a draftsman, thanking staff people for their help?
14. Does he pay attention to deadlines?
15. Does he effectively use the skills of subprofessional employees who work with him?
16. Is he interested in engineering work only because he can do what he wants to do in his profession?
17. Is he overly sensitive in his relation with people?
18. Is his educational background broad?
19. Has he been effective as a member of a professional group?
20. Do his colleagues respect him as a person?

Engineers and Management

As a group, engineers and other professionals have advantages and disadvantages for management work. They have the necessary intelligence and analytical ability, they recognize the importance of getting facts before making a decision, they tend to be objective, and they are work-centered. But they may dislike the kinds of details associated with management work, they shy away from personal involvement in human relations problems, and they may be indecisive in the managerial sense because they may not be comfortable in making a decision when adequate data are not available.

Management would place more reliance in merit rating the engineer, if the sole basis for it was that of practicality and purely theoretical considerations were eliminated. The merit rating program, how it works, its objectives and results, must be known to both the engineer and management. It can be started as a part of getting the engineer to improve his performance, to keep up his good work or take some positive steps toward self-improvement.

Keep Evaluating System

Once a merit-rating program for the engineer is under way, it is tempting to accept its operation unquestionably on the assumption that, since it was formulated to begin with, it must be operating effectively. Yet many a program, good on paper, has fallen down in practice. One way to find if your company merit-rating program has gone off tracks is to have a complaint from your engineers. To check on the program, follow-up and see where the engineer and his boss agree and disagree.

Assessment is the crux of merit rating the engineer. It involves obtaining, interpreting, and matching two basic kinds of information: (1) what traits the job requires and (2) what the engineer's traits are.

The "can do" and "will do" traits listed below will have some bearing on almost any engineering job. Not all are equally important. Management must determine the order of relevance on the basis of job analyses and company qualification specifications.

1. Job knowledge and skill—Degree to which the engineer has mastery of knowledge and skill required to perform duties of the position.

2. Mental alertness — Degree to which the engineer possesses the capacity or learning ability required to perform his job duties.

3. Health and physical condition — Degree to which the engineer has physical vigor and physical equipment required in job.

4. Verbal expression—Degree to which engineer is able to express his ideas orally with ease, clarity, logic, and in an organized manner.

5. Job motivation — Extent to which engineer exhibits the habits, motives, and drive to produce in his job.

6. Stability — Extent to which engineer has exhibited steadiness of purpose and developed habit of dependability.

7. Perseverance—Extent of engineer's capaccity to persist in spite of difficulties in any given task undertaken.

8. Self-reliance — Extent to which engineer has the habit of doing things for himself rather than depending on others.

9. Cooperation — Extent to which engineer is willing to work with others to achieve a common goal.

10. Competitiveness — Extent to which engineer will accept activities in which it is possible to compare his work record with that of others.

11. Loyalty — Extent of engineer's willingness to put the interests of his employer above his own.

12. Ability to get along with others — Extent to which engineer can establish good working relationships and gain personal acceptance by people.

13. Leadership — Degree to which engineer possesses the capacity to organize his work, or direct activities of others.

14. Acceptance of responsibility — Extent to which engineer is willing and able to assume responsibility for results of his work.

15. Emotional maturity — Degree to which engineer has an integrated and balanced personality.

16. Attitudes — Extent to which engineer's attitudes toward work, people, and work situations would facilitate rather than hinder effective performance.

Finally, the summary evaluation is gained which determines whether or not the engineer has the ability to do job, his motivation to do a good job, his likelihood of remaining on job, his suitability of personality, and effect of work pressures.

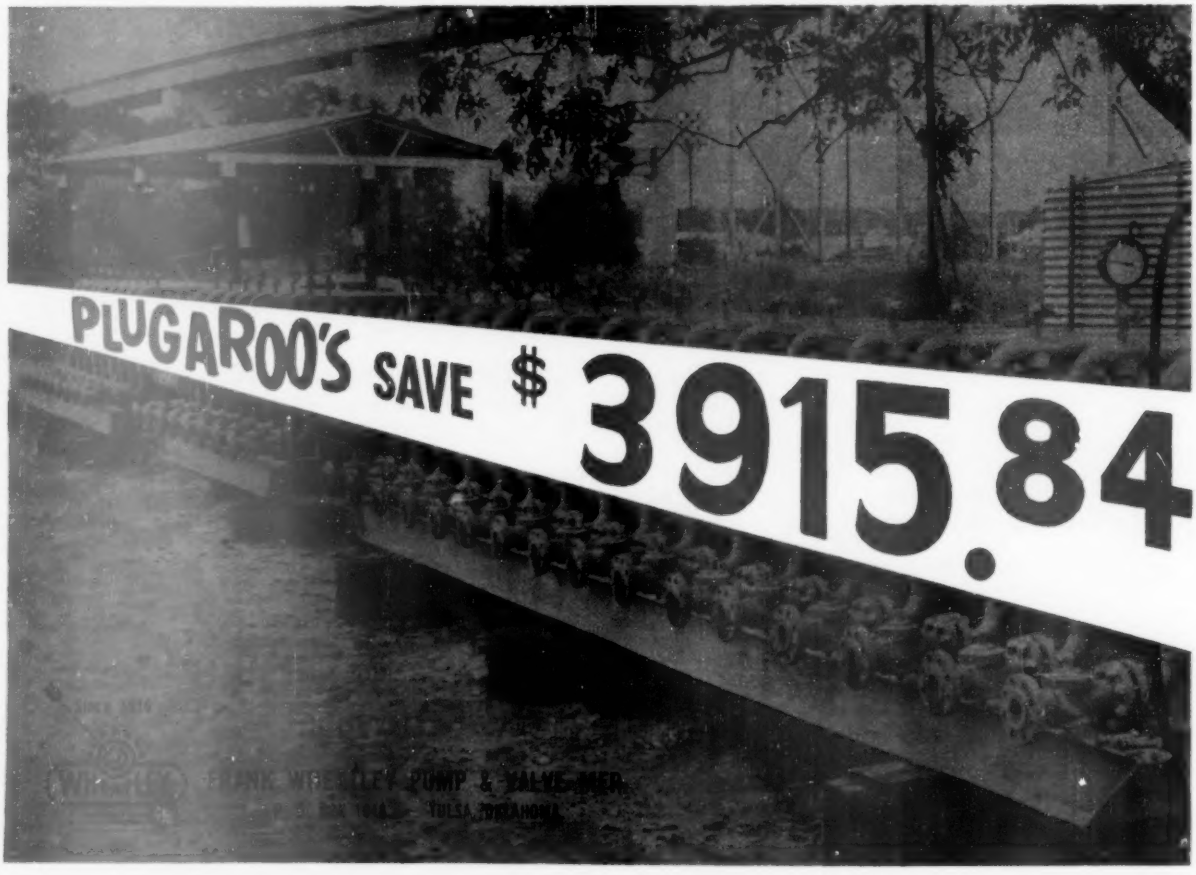
Merit rating should be explored and the same scientific principles used in engineering can be applied in the most practicable manner.

Take This Test

The engineer who wishes to develop himself professionally must, first of all, know his strength and weakness before trying to improve. Do exactly what an engineer would do — investigate and inspect.

To get a quick picture of where you stand as a professional worker use this test and see for yourself.

Give yourself 3 for Outstanding, 2 for Adequate, 1 for Fair but need help, 0 for Weak.



The sum of all the answers give you your grade: 100-Outstanding; 85-Adequate; 70- Need help; 55-Weak. What's your rate —?

- ☐ In self-assuredness and confidence.
- ☐ In giving effective instructions.
- ☐ In talking with others about work problems.
- ☐ In giving ideas, suggestions, and viewpoint.
- ☐ In giving cooperation.
- ☐ In answering questions on work procedures.
- ☐ In maintaining good working relationships.
- ☐ In creating job enthusiasm.
- ☐ In dealing with superiors.
- ☐ In using performance requirements.
- ☐ In improving job through simplification.
- ☐ In planning work.
- ☐ In coordinating work.
- ☐ In using professional standards.
- ☐ In effectiveness with people.
- ☐ In judgment.
- ☐ In selling ideas.
- ☐ In being self-reliant.
- ☐ In accepting criticism.
- ☐ In acting with deliberation.
- ☐ In making prompt decisions.
- ☐ In ethical conduct.
- ☐ In calm action.
- ☐ In being an effective negotiator.
- ☐ In ambition.
- ☐ In having stamina and vigor.
- ☐ In professional knowledge.
- ☐ In experience.
- ☐ In attitude toward programs.
- ☐ In accepting responsibility.
- ☐ In administrative judgment.
- ☐ In verbal ability.
- ☐ In actual job performance.
- ☐ In potential.
- ☐ In self-development.
- ☐ In increased productivity.
- ☐ In supervising.

About the Author

Robley D. Stevens, LLB, LLD, is a collector of over 10,000 autographed letters, pictures, and manuscripts from world-famous people of the past 25 years.

He is a Washington correspondent, management consultant, specializing in public-labor-personnel relations, and co-author (with Professor E. W. Mounce) of numerous publications, such as "Space Travel Guidebook," "Your Government Notebook," and other popular books. ■

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4"	600#	S.E.	214.00	121.77	92.23
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3"	800#	S.E.	146.59	62.37	84.22
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Price Wars Hit Third Quarter

by Ernestine Adams

Profits were sliced in the third quarter mainly by gasoline price wars. Independent refiners highlight the drop; independent producers did better than in 1960. For the 61 companies in our survey third quarter earnings were 3.7% under 1960 but nine months reports showed an increase of 7.3%.

Apco (formerly Anderson Prichard's refining, transportation and marketing) states: "Earnings in the third quarter as compared to a year ago have been substantially reduced due to excessive crude runs, destructive competition and uncalled-for price wars due primarily to a phobia for growth and the irresponsibility of management principally . . . larger companies seeking to expand markets at a rate much faster than the normal increase in market demand."

Continental spreads its reasons for lower earnings over "lower product selling prices, reduced crude oil production, higher intangible development costs and surrendered lease charges, increased salary and wage rates, and higher interest expenses."

Although Standard Indiana had slight change from 1960, it reported, "Price cutting on gasoline and other refined products was particularly severe during the third quarter."

It was pointed out in the Tidewater release that "consistent company attention to profit improvement and lower operating costs have been largely offset by a reduction in profit margins due to unstable price conditions."

Last year product prices were improving somewhat in the third quarter, according to Ohio Oil, but this year showed a steady decline.

Some companies made an effort to curtail refining runs. Cities Service held runs at about the same level as 1960. Sun Oil reduced its runs from 63 to 60 million bbl in nine months.

Phillips said, "Petroleum product prices have been depressed since mid-summer, resulting chiefly from price wars."

The story overseas was the same. Jersey Standard said significant sales volume gains abroad were largely offset by price weaknesses. British Petroleum's first half demonstrates this. Volume was up 4% and profits down 28%.

Strikes hurt some companies. Kerr-McGee suffered a strike at its nuclear subsidiary. Murphy lost money on the 28-day strike at its Superior refinery. Strikes at Sinclair's four refineries in the third quarter wiped out gains in first half. Gulf's Port Arthur refinery closed.

There were exceptions to the down trend, especially among producers. For Aztec, output of crude oil and distillates rose 20% and gas sales 10%. Helmerich & Payne, Hugoton, Intex, Nortex, Pubco, Tex-Star and Wilcox bucked the trend and registered third quarter increases.

Union Oil of California reported: "Gains in natural gas and crude oil sales were responsible for most of the rise in total revenues."

As for the future, Pure Oil stated: "It is reasonable to expect, if the past is a fair criterion, that in due course common sense in orderly marketing of oil products will prevail."

Atlantic Refining feels it has built a solid basis for progress: "We continuously strive to streamline company organization for effective use. As a result of task force studies and the use of outside consultants, we believe we are in a better position than ever before to perform."

In its annual report, General American commented: "Despite the admittedly adverse industry conditions, your management is decidedly optimistic for improved company results in fiscal 1962. Intensive efforts during the past year increased efficiency, resulting in higher production and reduced operating expenses."

Improvement in gasoline prices is possible, Signal reported. "Strengthening of gasoline prices through the fourth quarter of this year will help to offset the severe effect gasoline price wars had on profits from March through September."

Texas Pacific voiced encouragement: "Our earnings could be substantially changed by several factors. Our gas revenue should increase, remedial work costs will probably decrease, and some exploratory wells now drilling may be brought in as producers."

Predictions of Texaco included "a fairly good fourth quarter, assuming that we have a more normal winter. Total domestic demand for 1961 should be about 2% more than in 1960."

■

TABLE 1. PETROLEUM INDUSTRY FINANCIAL REPORTS FOR FIRST NINE MONTHS.

Company	Third Quarter						Nine Months					
	Gross			Net			Gross			Net		
	1961	1960	% Change	1961	1960	% Change	1961	1960	% Change	1961	1960	% Change
Ambassador	1,522	1,610	— 5.5	(65)	270	—	4,437	4,888	— 9.2	330	964	— 65.8
Amerada	24,860	24,240	+ 2.6	6,529	6,792	— 3.9	75,582	76,068	— 0.6	20,670	20,515	+ 0.8
Apco[2]	14,407	15,558	— 7.4	750	1,098	— 31.7	43,577	43,857	— 0.6	2,494	1,999	+ 24.8
Ashland[3]	—	—	—	—	—	—	312,875	303,673	+ 3.0	15,251	14,927	+ 2.2
Atlantic Ref.	125,696	131,488	— 4.4	10,050	10,488	— 4.2	416,420	410,703	+ 1.4	31,699	27,405	+ 15.7
Aztec O & G	2,452	1,862	+ 31.6	1,233	1,000	+ 23.3	7,131	6,029	+ 18.3	3,881	3,443	+ 12.7
Champlin O & Ref.	21,282	22,684	— 6.2	1,954	2,734[4]	— 28.5	65,477	63,829	+ 2.6	7,295	6,148	+ 18.7
Cities Service	230,114	220,993	+ 4.1	6,833	7,865	— 13.1	731,173	714,723	+ 2.3	30,753	26,538	+ 15.9
Clark O & Ref.	21,193	20,661	+ 2.6	264	794	— 66.8	64,477	62,755	+ 2.9	281	1,002	— 72.0
Coastal States[1]	6,307	4,406	+ 4.3	907	635	+ 4.3	24,559	17,586	+ 34.7	4,148	2,951	+ 40.6
Colorado O & G	13,555	11,661	+ 16.2	993	951	+ 4.4	37,381	34,248	+ 9.1	3,145	638	+392.8
Consolidated O & G	658	373	+ 76.0	106	(2)	—	1,377	1,119	+ 23.0	143	(6)	—
Continental	214,620	213,435	+ 0.6	13,991	17,365	— 19.4	635,303	628,388	+ 1.1	42,713	46,348	— 7.8
Crescent Corp.	5,422	5,334	+ 1.6	424	463	— 9.2	16,776	16,494	+ 1.7	1,258	1,879	— 33.0
Eason Oil	1,023	854	+ 19.8	172	51	+237.3	2,908	2,820	+ .031	433	298	+ 45.1
General American	—	—	—	—	—	—	31,866	27,958	+ 14.0	4,102	2,261	+ 81.4
Getty Oil	15,768	15,608	+ 1.0	2,044	1,953	+ 4.7	52,475	47,329	+ 10.9	9,011	6,382	+ 41.2
Gulf	788,333	767,402	+ 2.7	79,234	81,814	— 3.2	2,402,650	2,353,644	+ 2.1	248,935	237,910	+ 4.6
Helmerich & Payne[1]	3,124	2,734	+ 14.3	579	11	+5163.6	8,393	7,206	+ 16.5	1,696	370	+358.4
Hugoton Prod.	1,162	850	+ 36.7	505	342	+ 47.7	4,152	4,036	+ 2.9	2,187	2,188	— 0.1
Intex Oil	513	520	— 1.3	106	17	+523.5	1,512	1,550	— 2.4	291	(16)	
Kern County	27,790	24,691	+ 12.6	4,160	3,900	+ 6.7	75,310	70,498	+ 6.8	12,472	11,172	+ 11.6
Kerr-McGee[1]	—	—	—	2,515	4,844	— 48.1	157,307	157,785	+ 11.1	17,003	7,287	+133.3
Kewanee Oil	—	—	—	1,185	625	+ 90.0	—	—	—	4,294	7,057	— 39.1
Leonard Ref.	13,699	14,504	— 5.5	366	610	— 40.0	40,935	41,286	— 0.8	763	1,378	— 44.6
Louisiana Ld & Ex.	11,874	11,571	+ 2.6	6,155	6,040	+ 1.9	36,011	33,721	+ 6.8	18,029	17,102	+ 5.4
Maracaibo	354	384	— 7.8	31	39	— 20.5	1,130	1,226	— 7.8	128	157	— 18.5
Midwest Oil	6,158	5,223	+ 17.9	2,409	1,500	+ 60.6	17,776	15,291	+ 16.3	6,538	4,899	+ 33.5
Murphy Corp.	24,182	23,482	+ 2.9	1,270	1,425	— 10.8	70,994	66,878	+ 6.2	3,610	3,323	+ 8.6
Nortex O & G	546	510	+ 7.1	112	34	+229.4	1,579	1,426	+ 10.7	313	98	+219.4
Ohio Oil	84,967	87,143	— 2.5	8,309	9,677	— 14.1	263,863	263,116	+ 0.3	27,609	27,410	+ 0.7
Olin O & G	11,539	11,351	+ 1.7	1,142	979	+ 16.7	35,340	34,972	+ 1.1	3,018	2,604	+ 15.9
Phillips	302,531	299,274	+ 1.1	25,525	27,172	— 6.1	909,821	902,373	+ 0.8	80,427	78,920	+ 1.9
Pure	—	—	—	6,483	6,457	+ 0.4	—	—	—	17,357	20,213	— 14.1
Producing Prop.	3,417	2,585	+ 32.2	243	205	+ 18.5	9,151	7,106	+ 28.8	808	1,030	— 21.6
Pubco Pet.	1,058	526	+101.1	452	167	+170.7	2,903	1,660	+ 74.9	1,213	438	+176.8
Quaker State	12,884	13,962	— 7.7	270	595	— 54.6	40,095	40,349	— 0.6	1,018	1,361	— 25.0
Richfield	75,199	75,908	— 0.9	7,483	6,788	+ 10.2	212,659	213,999	— 0.7	16,662	20,776	— 9.8
Shamrock	17,408	16,896	+ 3.0	2,448	2,478	— 1.2	47,851	49,190	— 2.7	7,259	7,496	— 3.2
Shell	459,957	456,008	+ 0.8	33,331	34,996	— 4.8	1,387,740	1,354,206	+ 2.5	103,014	104,308	— 1.2
Signal O & G	89,694	79,769	+ 12.4	2,940	4,356	— 32.5	252,686	231,649	+ 9.1	8,867	11,960	— 25.9
Sinclair	287,442	291,894	— 1.5	3,388	12,842	— 73.6	904,381	914,854	— 1.1	26,550	34,504	— 23.1
Skelly	60,391	63,739	— 5.3	5,258	6,033	— 12.8	185,516	188,975	— 1.8	17,071	17,122	— 0.3
Socony Mobil	—	—	—	52,800	52,500	+ 0.8	—	—	—	161,600	135,900	+ 18.9
Standard, Cal.	567,884	548,343	+ 3.5	68,725	70,666	— 2.7	1,592,603	1,529,053	+ 4.2	205,207	199,225	+ 3.0
Standard, Ind.	497,493	508,017	— 2.1	37,848	37,939	— 0.2	1,524,093	1,508,333	+ 1.0	112,025	102,826	+ 8.9
Standard, N. J.	2,418,000	2,263,000	+ 6.8	185,000	186,000	— 0.5	6,906,000	6,562,000	+ 5.2	570,000	501,000	+ 13.8
Standard, Ohio	97,034	92,895	+ 4.5	6,311	6,618	— 4.6	283,456	274,907	+ 3.1	17,961	17,574	+ 2.2
Sun Oil	192,202	181,207	+ 6.1	14,173	14,820	— 4.4	593,228	548,007	+ 8.3	38,220	34,852	+ 9.7
Sunray Mid-Con	119,080	115,239	+ 3.3	8,215	10,335	— 20.5	357,617	343,671	+ 4.1	30,132	29,078	+ 3.6
Superior Oil[5]	36,133	33,298	+ 8.5	4,232	6,056	— 30.1	111,245	95,146	+ 16.9	17,160	18,550	— 7.5
Texaco	—	—	—	110,513	101,642	+ 8.7	—	—	—	309,239	278,984	+ 10.8
Texas Pacific	6,377	6,445	— 1.1	1,403	1,791	— 21.7	19,902	19,691	+ 1.1	4,926	5,759	— 14.5
Tex-Star[6]	461	364	+ 26.6	227	170	+ 33.5	1,689	1,272	+ 32.8	825	586	+ 40.8
Tidewater Oil	151,667	146,952	+ 3.2	7,212	13,074	— 44.8	450,591	434,681	+ 3.7	21,930	31,351	— 30.1
TXL Oil	3,234	2,921	+ 10.7	503	566	— 11.1	9,808	9,431	+ 4.0	1,823	1,956	— 6.8
Union Oil Calif.	139,366	140,503	— 0.8	10,577	10,352	+ 2.2	406,461	401,175	+ 1.3	27,348	23,721	+ 15.3
Union Texas Nat'l	22,932	18,109	+ 26.6	3,691	3,344	+ 10.4	69,572	58,242	+ 19.5	10,648	9,550	+ 11.4
Universal Consol	1,812	1,840	— 1.5	620	653	— 5.1	6,100	5,593	+ 9.1	2,617	1,880	+ 39.2
Western Develop.[1]	519	468	+ 10.9	114	149	— 23.2	2,113	2,309	— 8.5	719	1,026	— 29.9
Wilcox	1,173	1,562	— 24.9	186	133	+ 39.8	4,119	4,392	— 6.2	569	579	— 1.7
TOTAL	7,238,468	7,002,848	+ 3.4	754,434	783,211	— 3.7	21,932,146	21,217,366	+ 3.4	2,337,688	2,179,156	+ 7.3

[1] Fiscal year ending June 30 instead of 9 month. Quarter ends Sept. 30.
[2] Third quarter actual. Nine months pro forma basis.
[3] Fiscal year ends September 30.
[4] Includes out of period adjustment by virtue of settling FPC rate cases.
[5] Third quarter ends May 31.
[6] Fourth quarter and fiscal year end August 31.

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Jan. 8-12 — Society of Automotive Engineers, annual, Cobo Hall, Detroit, Mich.

Jan. 17 — Mississippi Petroleum committee meeting, Heidelberg Hotel, Jackson, Miss.

Jan. 17-19 — National Assn. of Corrosion Engineers, Canadian region eastern division conf., King Edward Hotel, Toronto, Ont.

Jan. 19 — Natural Gas Processors Assn., Gulf Coast regional, Robert Driscoll Hotel, Corpus Christi, Tex.

Jan. 21-23 — Kansas Petroleum Industries committee, 10th annual convention, Broadview Hotel, Wichita, Kansas.

Jan. 21-26 — ASTM committee, D-2 meeting, Chase Park-Plaza hotels, St. Louis, Mo.

Feb. 4-7 — American Institute of Chemical Engineers, national meeting, Statler Hotel, Los Angeles, Calif.

Feb. 14-16 — Southwestern Legal Foundation, 13th annual on law of oil, gas and taxation, Southwestern Legal Center, Dallas, Tex.

Feb. 15 — National Industrial Conference Board, board members, Waldorf-Astoria Hotel, New York City.

Feb. 16 — Natural Gas Processors Assn., South Louisiana regional meeting, Lafayette Petroleum Club, Lafayette, La.

Feb. 18-22 — AIME annual meeting, New York City.

Feb. 26-28 — AAPG, Rocky Mountain section, 12th annual, Salt Lake City, Utah.

Feb. 28-Mar. 2 — International Oil & Gas Educational Center, institute on economics of the gas industry, Southwestern Legal Center, Dallas, Tex.

Feb. 28-Mar. 2 — API Division of Production, Southern district meeting, Rice Hotel, Houston, Tex.

Mar. 2 — Ohio Oil & Gas Assn., winter meeting, Deshler-Hilton Hotel, Columbus, Ohio.

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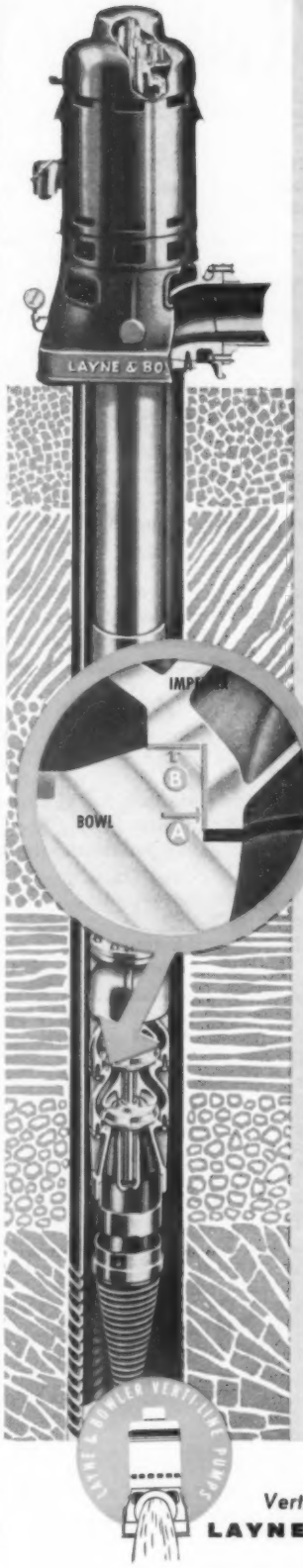

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"And as the lion came charging at me," related the famous explorer. "I turned and made a leap for an overhanging branch 25 ft above the ground."

"And did you make it?" asked his listener, breathlessly.

"Not on the way up," was the reply, "but fortunately I caught it on the way down."

The wife was being teased by a neighbor who'd seen her husband in the company of a fancy-looking blonde dish. The wife calmly squelched her annoyer by saying: "All I know is that Joe brings home his pay check each week. Anything he can get for nothing at the age of fifty-five he's entitled to!"

Overheard at the beach: "Tell me, is that girl wearing a black bathing suit or is that a bruise on her hip?"

There's no thrill like kissing a girl and dropping an ice cube down her back at the same time.

After viewing the day's takes, the tempermental movie actress complained to the chief cameraman, "You're not photographing my best side."

"How can I?" he snapped. "You are always sitting on it."

Two old friends met for the first time in several years. "Hear about poor John? He dropped dead outside Hangover Bar."

"Going in or coming out?"

"Going in."

"What a terrible tragedy."

FOR SALE

Complete shop tools and equipment for oilfield service. Good location. Will sell building and equipment. Large parts department; two pick-up trucks; several engines. Will consider selling all shop equipment and parts and lease building. Owned by widow woman that wants out of business. Criss Engine Service, 1032 S. E. 25th St., Oklahoma City, Okla. Phone Mrs. Mickey Criss, VI 3-4564 or OR 7-4411, or come by shop.

She was trying on a beautiful fur coat. "I wish," she sighed, "it was called something else besides a broadtail. My husband fancies himself a comedian."

"Just think of it," exclaimed the romantic young man, "a few words mumbled over your head and you're married."

"Yes," agreed the old cynic. "And a few words mumbled in your sleep and you're divorced."

WANTED: PUMPING UNITS

160,000 IPT double reduction No. 1 used pumping units needed at Gorham, Kan. Give complete description, make and date of manufacture. Quote price present location also price delivered. Contact H. D. Lawver, Home-Stake Production Co., 2302 Philtower Bldg., Phone LU 4-5281, Tulsa, Okla.

A young about-to-be bride had been taking driving lessons in order to help her husband at the wheel on their honeymoon trip. In all the excitement of wedding preparations, however, she only found time to get a learner's permit.

Came the wedding and reception at the bride's home, and the happy young couple departed in a shower of rice for their long trip. A few minutes later, the guests were startled to see the bride rush back into the house.

"Lucky we hadn't gone very far," she giggled breathlessly.

"I forgot my learner's permit!"

BUSINESS OPPORTUNITIES

ROYALTY BUYERS — income-producing gas-distillate royalty, new deep, dual-completed wells with additional sands behind the pipe. Ogden Oil Company, P. O. Box 409, Taylor, Texas. Phone EL 2-3352.

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REDUCING HIDDEN EXPLORATION COSTS — D. M. E McLarty, Petroleum Consultant, Denver

PROBLEMS OF FOREIGN EXPLORATION — John C. Dunlap, Consulting Geologist, Dallas

CUTTING COSTS OF WELL COMPLETIONS AND OPERATIONS — Marion H. Stekoll, President, Stekoll Petroleum Company

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She: "Do you know what they are saying about me?"
He: "Why do you think I'm here?"

We know of a couple who discussed the question of having children before they were married but they decided not to have any until after they were married.

One way to keep your teenage daughter out of hot water is to put dirty dishes in it.

Some must sow wild oats to grow sage.

Then there was the politician who kissed so many hands he had dishpan lips.

If you want to know how your girl will treat you after you're married, just listen to her talking to her little brother.

Old maid to robber: "Oh, gracious, frisk me again."

The shipyard worker was trying to teach a new lady riveter what to do.

"I'll hold the rivet," he said, "and when I nod my head, you hit it with the hammer."

She did.

He left a widow and three children.

A change of lipstick now and then is relished by the best of men.

We are told that creatures of the wild are born with a natural spirit of cooperation. This is particularly true of the wolf and the stork, who usually work the same neighborhood.

Headline in recent N. Y. newspaper: Father of 10 shot, mistaken for rabbit.

Experience is what permits you to make the same mistake again without getting caught.

"Who gave the bride away?"
"Nobody. I could have, but I kept my mouth shut."

The man with laryngitis whispered over the phone, "Is the doctor in?"

"No," the secretary whispered back, "come on up."

Reporter: "Tell me, Pop, to what do you attribute your longevity?"
Retired Truck Driver: "Well, it's thisaway, sonny. I waste no energy resisting temptation."

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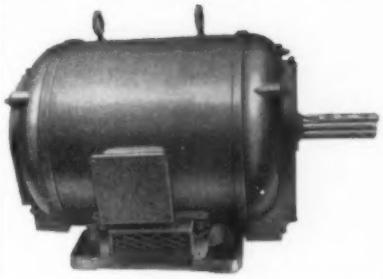

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Management People

Five executive changes for Texaco are: Arch W. Baucum and Marion J. Epley Jr. were elected to the newly created positions of executive vice president; John W. Green, vice president, domestic sales, was elected senior vice president in charge of world-wide marketing, succeeding Epley; Homer O. Woodruff, general manager, domestic producing, succeeded Baucum as vice president, and John I. Mingay, general manager, domestic sales department, succeeded Green.

Admiral Arleigh Burke, U. S. Navy (Ret.) was elected to the board and the executive committee.

Union of California's wholly owned foreign corporation, Unoco Trading, was reorganized to permit expansion of its activities. F. K. Cadwell is president; Charles F. Parker, vice president; D. C. Gregg, secretary; W. R. Craig, treasurer and comptroller; Reese H. Taylor, Fred L. Hartley, and H. W. Sanders, directors.

A. L. Nickerson

H. Willetts

Albert L. Nickerson was elected chairman of the board of directors of Socony Mobil, succeeding Fred W. Bartlett, retired. Nickerson has been president of the company since 1955 and chief executive officer since 1958. He continues as chief executive officer.

Herbert Willetts was elected president. He has been an executive vice president of Socony Mobil and president of Mobil. He is also a director.

F. H. Moore

Fred H. Moore was elected a member of the board of directors and an executive vice president. In addition, he succeeds Willetts as president of the Mobil Oil Company division. He now is executive vice president of Mobil.

Paul R. Schultz, president of Blackwell Oil & Gas, Tulsa, has been appointed as full time assistant and

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consultant to Senate Committee on national fuels policy. He was chairman of IPAA's Import Policy Committee and has a practical knowledge of industry operations. John Ryan, Humble economist, is also working with the committee.

Otto N. Miller was elected president of Standard of California, succeeding T. S. Petersen, retired. He has 27 years experience with the company, notably in refining, Eastern Hemisphere operations and research, has been a director since 1959 and a vice president since 1954. Petersen is widely known in the petroleum industry and as a San Francisco civic leader. He continues as a director or trustee of many leading corporations and institutions.

Dan M. Krausse, Big Spring, Texas, joined Dresser Industries, Inc., in Dallas as vice president. He was senior vice president of Cosden Petroleum Corporation and will be available for consultative advice indefinitely. He is working with the Dresser companies related to oil and gas drilling equipment and services.

R. L. Tollett, Cosden's president and general manager for 21 years, assumed Krausse's duties.

D. M. Krausse

H. Decker

Harold Decker, president of Highland Oil Company, Houston, succeeded Alvin C. Hope, San Antonio, as president of the Independent Petroleum Association of America. One of the early petroleum engineers, Decker has long experience in the petroleum industry. He began his petroleum engineering work with Tidal Oil Company, went with Skelly, Seaboard and in 1945 with Pan American, advancing to vice president, general manager of production and gas companies, and director.

Newly elected executive committeemen for IPAA are: W. T. Blackburn, Denver; Elmo Holder, Evansville, Indiana; George C. Martin, Oklahoma City; Patrick J. McDonough, Billings, Montana; H. A. True Jr., Casper, Wyoming; W. M. Vaughey, Jackson, Mississippi;

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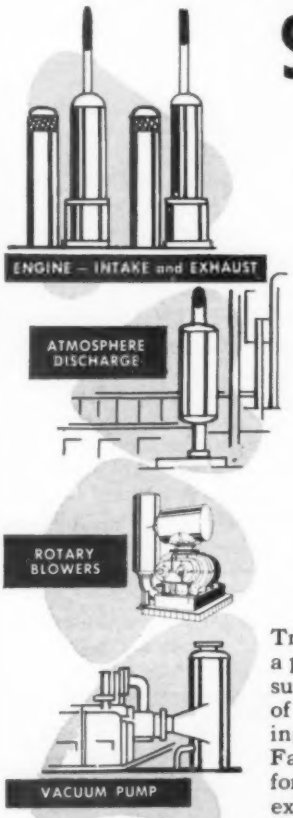

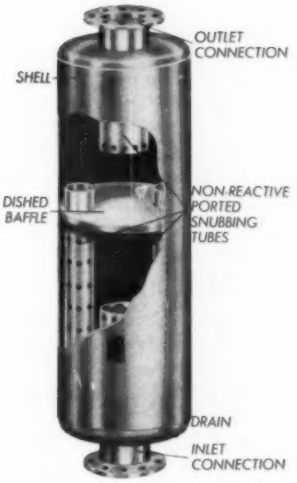

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Corrosive Water Fight Can Be Lost Before Pipe Goes Into the Line

Litewall steel pipe, cement-mortar lined, is proving highly successful in resisting the corrosive effects of oil-field brines in water flood installations and waste water disposal lines. But the record is marred by occasional puzzling failures—which have only lately been traced to an unsuspected source!

DANGER!

In most instances of failure, the trouble has been caused by out-of-round pipe—pipe which has lost true concentricity and straightness between the pipe mill and the lining plant. It is extremely difficult, if not impossible, to apply a cement-mortar lining of uniform thickness and density to pipe which is out of round by more than 1%, or whose straightness varies more than ⅛" in 10 feet. Litewall pipe can easily depart more than this from true dimension during shipment from pipe mill to lining plant. When this happens, the fight against corrosion may be lost before the pipe goes in the line.

SOUTHERN PIPE SOLUTION

Cement-lined litewall steel pipe from Southern Pipe has been developed to protect oil field lines against this hazard. Southern's Cemcote Steelcor pipe is manufactured to rigid specifications. It is lined with a dense, uniform coating with no zone of weakness.

True pipe dimensions are held at every step to insure against "out-of-round" pipe failure, because Southern Pipe fabricates its own pipe to help you whip the problem of corrosion.

PROPER CEMENT IMPORTANT

Many cements provide incomplete protection. Southern Pipe matches its cement-mortar linings to the particular type of corrosion which will be encountered in the specific application.

Southern Pipe uses one of several special cements with a low content of tricalcium aluminate, and one with zero tricalcium aluminate.

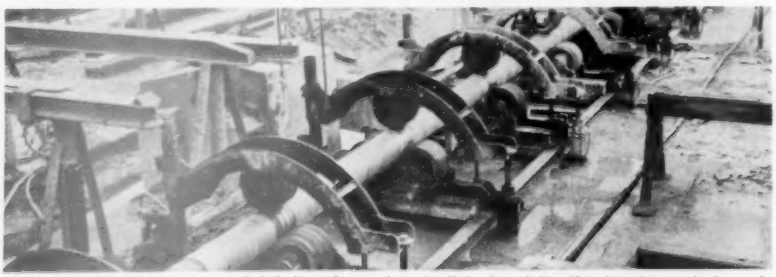
Reason?

Sulfates in the brine react with the calcium hydroxide in the cement, forming a compound which in turn reacts with tricalcium aluminate to form an expanding compound which causes rapid mechanical deterioration of the lining, with consequent corrosion and line failure.

LONG-RANGE INVESTMENT

Your initial investment in Southern Pipe's "packaged" line (one manufacturer, one responsibility) may be a little higher, due to freight from California, but on a long term basis your costs will go down. Why? Southern Pipe's cement-mortar lined litewall steel pipe goes into the line to *stay* – less replacement, less downtime, lower labor costs, fewer service interruptions.

Dollar for dollar, the soundest "corrosion-free" investment in pipe you can make is Southern Pipe.



Spinning machine insures even distribution of cement mortar lining by rotating the pipe at a constant speed.

T. M. Martin, El Dorado, Arkansas, and from Texas, C. J. Davidson, Fort Worth; F. Clinton Edwards, Midland; Jake L. Hamon, Dallas; J. Stuart Hunt, Dallas; J. C. Hunter, Jr., Abilene; E. Bruce Street, Graham, Watson W. Wise, Tyler.

U. H. Ohrman, left, was elected president of Petroleum Electric Power Association at a special directors meeting in October. Ohrman, Texas Power & Light Co., fills the vacancy created by the death of the former president and a director, B. F. Thompson, who died suddenly Sept. 20 of a heart attack in Mobile, Ala. Bert H. Morphis, right, Public Service Company of Oklahoma, was elected director.

Donald M. Cox, Humble coordinator of supply and transportation, accepted a management position with Esso A. G. in Germany. He had previously served as general manager of the supply department of Esso Standard.

Charles A. Perlitz Jr., executive vice president of Continental, was elected chairman of the board of Hudson's Bay Oil and Gas Company, Ltd. J. R. Murray, managing director of the latter, was elected vice chairman. Perlitz succeeded L. F. McCollum, president of Continental, who continues as a Hudson director.

Humble made three changes in management of southwest and central regions. J. H. Galloway, Houston, general manager of Southwest region since last December, became general manager of Central region; R. P. Ryan, general counsel of Central region, was named successor to Galloway as general manager, Southwest region, and A. L. Deaton, former area manager at Mattoon, Illinois, succeeded Ryan.

George W. Schwer was elected an assistant controller, responsible for direction of the annuity and thrift accounting organization in the headquarters controller's department.

Organizational changes of pur-

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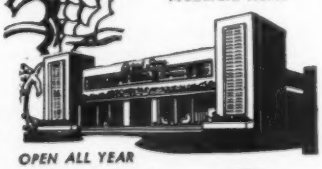

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chasing functions of Southwest region and Baytown refinery are: John C. Calkins is new purchasing agent for Southwest region and John G. Traxler, who was serving as assistant superintendent of the maintenance and construction division at Baytown refinery, became purchasing agent there.

J. Howard Pew, a director and former president of Sun Oil, was awarded a 60-year pin at a dinner at Sun Center, Feltonville. Only one other employee in the history of the company has received a pin for such extended service.

Honored for outstanding contributions to the oil industry at the American Petroleum Institute's 41st annual meeting in Chicago were:

Medical Advisory Committee — Dr. L. E. Curtis, Standard of California; Dr. T. M. Frank, American Oil; Dr. G. M. Saunders, Socony.

Safety — Walter Boon, Sun; J. C. Howard, American Oil; W. E. Lovejoy, Standard of California; E. G. Miller, Humble.

Committee on Statistics — Maynard I. Landa, Cities Service.

Finance and Accounting — W. J. Arnold, Pure Oil.

Committee on Public Affairs — Joseph P. Walsh, Sinclair.

API awarded J. C. Donnell II, president of Ohio Oil, the Carl A. Young Memorial Award for meritorious service to the petroleum industry. This award was in recognition of his outstanding service in 1951 and 1952 as API president for production and his chairmanship from 1954 through 1959 of the program and budget review committee.

T. B. (Tom) Murphy was elected president of both Western Oil & Fuel Company and of International Refineries, Inc. He has been executive vice president of Western Oil & Fuel since May, 1961.

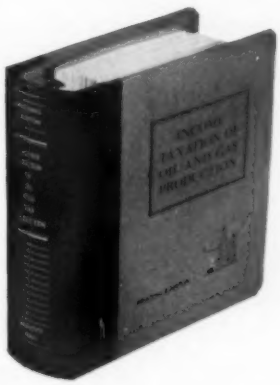
Deaths

Sam M. Gladney, 62, Dallas civic leader and an official of Sun Oil Company, died November 11. In 1955 he received the distinguished service award from The Texas Mid-Continent Oil Gas Association for his leadership in civic and oil industry activities.

James A. Laing, 61, secretary and treasurer of Natural Gas Pipeline Company of America, died October 25.

Lewis McDonald, 77, retired vice president of Chicago Bridge & Iron Company, died October 20.

New Authoritative Guide
INCOME TAXATION OF OIL AND GAS PRODUCTION



Thanks to this long-needed guide, it is now possible to predict the tax consequences of your oil and gas operations. Here, in one convenient source, you can quickly locate the answer to practically any question that may come up. For example . . .

In what three ways can grantor and grantee reduce the tax burden of the lease bonus for each other?

How can you realize a capital gain on the sale of an oil payment?

How can you choose to expense or capitalize delay rentals so as to enjoy special tax benefits?

What 10 provisions of the Tax Code apply to sharing arrangements?

What six principles have the courts established as governing losses from oil and gas interests?

It would be hard to think of any question, however uncommon, that is not answered in INCOME TAXATION OF OIL AND GAS PRODUCTION. This volume is the result of a mammoth research project undertaken two years ago by Clark W. Breeding and A. Gordon Burton — two noted authorities who are partners in the firm of Peat, Marwick, Mitchell & Co.

Clip and mail this convenient order form TODAY for your copy of INCOME TAXATION OF OIL AND GAS PRODUCTION — Prentice-Hall's superb new loose-leaf, tab-indexed volume. This guide to all current tax regulations, that will pay dividends for years to come, is yours for only $25 per copy.

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Management Books

"Regions, Resources, & Economic Growth," by Harvey S. Perloff, Edgar S. Dunn, Jr., Eric E. Lampard, and Richard F. Muth. Published by The Johns Hopkins Press, Homewood, Baltimore 18, Maryland. Pages, 715. Price, $12.

This is a study prepared by Resources for the Future, Inc. (Ford Foundation supported). There is an attempt to analyze regional changes and the role they play in the development of the United States. It includes an historical background and a general economic report helpful in business planning for those companies whose activities are spread widely over the country. The study covers theories of growth and of the forces behind recent locational shifts in American industry and the impact of these shifts on differential regional economic growth.

"Space Travel Guidebook," by Robley D. Stevens. Published by W. A. Wilde Company, Natick, Massachusetts. Pages, 148. Price, $4.50.

This volume presents glimpses into man's conquest of flight, with over 100 official illustrations showing the advancement in air power and space exploration. The many chapters include the "Evolution of Man's Conquest of the Air," "Space Propulsion System," "The Astronaut Into Space Travel," and many others. Authentic photographs included in this book will acquaint the reader with the tremendous progress which has been made through the years, also the prediction of future events in space exploration.

"The Power of Black," a novel by M. B. Longman. Published by Rudo S. Globus, Inc., 40 West 55th Street, New York 19, New York. Pages, 472. Price, $5.95.

Many novels have been published about people in the petroleum industry and this is one of the best written of them all. The story goes back before the Civil War and follows the Ashe family through the struggle between the States, through the early Pennsylvania oil development and into the third and fourth generations, which follow the oil migration to Oklahoma and Texas.

M. B. Longman is a nom de plume, the authors are said to be an oil industry executive and a prominent writer.

"The Power of Black" is a remarkable job of recounting the action between men and the oil industry — each influenced by the other, not adversaries but not always comfortable together — the individual and the group.

Verdict: Worth a good reading.

Seventh Annual Institute on Mineral Law, edited by Carlof E. Lazarus. Published by the Louisiana State University Press, Baton Rouge 3, La. Pages, 175. Price, $7.50.

The institute was not held for the '59 season so the seventh program held by the Louisiana State University Law School and the General Extension Division covered two years. This volume is a collection of the papers presented, covering the changes in conservation and oil and gas laws in Louisiana.

"The Secretary of State," edited by Don K. Price. Published by Prentice-Hall, Inc., Englewood Cliffs, New Jersey. Pages, 200. Price, $3.50 (cloth).

In recent years every man in the industry has had occasion to be reminded of the fact that petroleum is international. Political ties with business, moreover, have been shortened and strengthened. Near to the top in this world situation is the Secretary of State. In this volume, the office of the Secretary of State as the head of a vast, expanding federal department deeply involved in vital domestic and world affairs, is examined by six authors familiar with the complex roll: Dean Acheson, former Secretary of State; Robert Bowie, director of the Center of International Affairs; John Sloan Dickey, president of Dartmouth College; William Y. Elliott, consultant to the Secretary of State; Paul Nitze, president of the Foreign Service Educational Foundation; Henry M. Wriston, president of the American Assembly.

"A Glossary of Petroleum Terms," edited by George Sell. Published by The Institute of Petroleum, 61 New Cavendish Street, London, W. 1, England. Pages, 39. Price, 5s. post free.

This third edition of the Glossary is, as the others, concerned mostly with refining terms, although there are a substantial sprinkling of production and drilling, marketing and standardization terms.

E. B. Evans, honorary editor, states, "Sometimes the words used in technology are standard English used in a special context to convey a particular idea, sometimes they are derived from Latin or Greek or they may have their origin in humour or even slang. The justification for a specialized vocabulary is that it must lead to economy of expression."

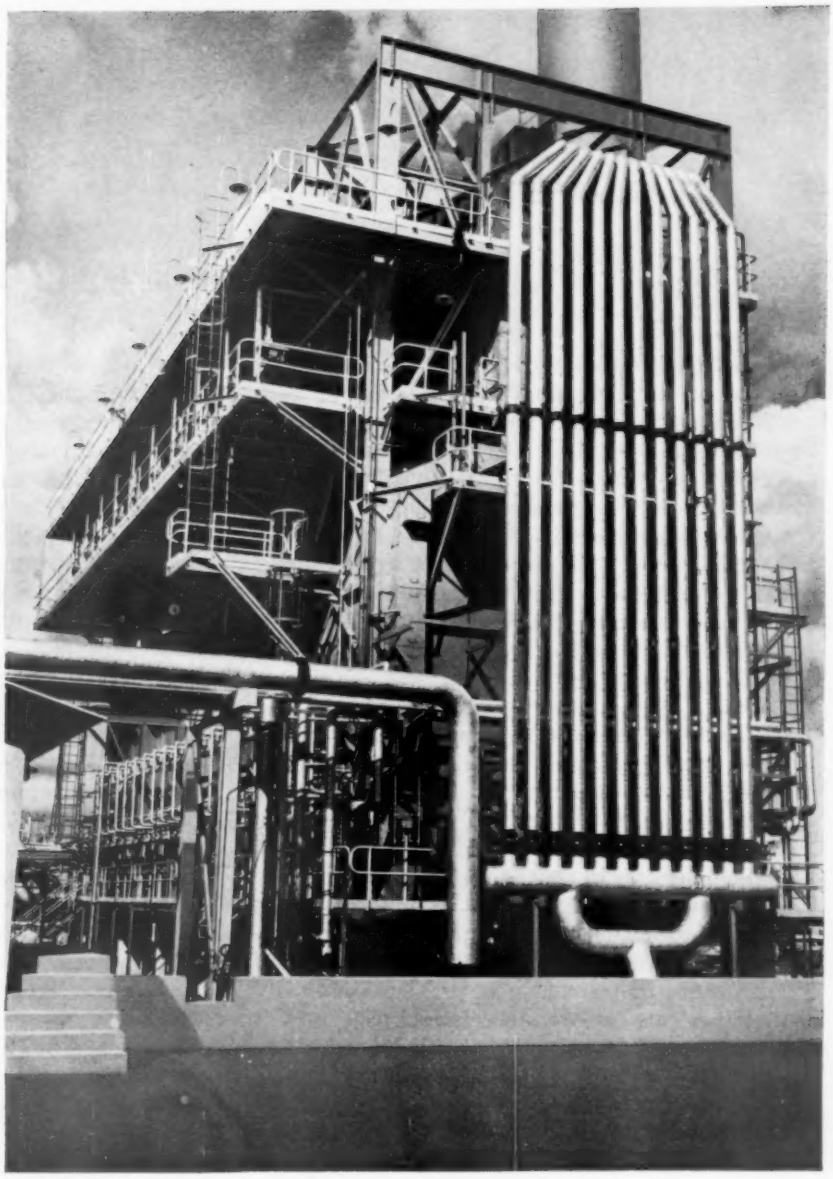
We remember in Europe the word "tower" was confusing to us. It was used as a drilling rig and in the United States it usually means a refining tower.

Twentieth-Century Petroleum Statistics — 1961. Published by DeGolyer & McNaughton, Dallas, Texas. Pages, 176. Price, $7.50.

These are charts and statistics gathered each year by the consultant company. The book includes foreign as well as domestic data. There are no original statistics but a collection from various sources.

"Petroleum Sourcebook . . . 1960," edited by Curtis Stevens. Published by National Petroleum Bibliography, Box 3586, Amarillo, Texas. Pages, 206. Price, $7.50.

This annual geographic index to petroleum literature and data lists the technical articles, papers, maps, books, and special publications of 1959, dealing with each continent, country, and state or province. More than 5000 references are cited, compiled from the trade press, as well as from publications of professional societies, state and federal agencies, and mapping, statistical and financial institutions. It is designed to serve as a desktop reference to regional information, and is particularly valuable in locating data on particular fields and geologic provinces. It may be ordered on approval if desired.



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Reasons for a Fuels Study

by John M. Kelly

Senate Resolution 105 authorizes the Committee on Interior and Insular Affairs, augmented by three Senators, to make a full and complete investigation of the current and prospective fuel and energy resources of the United States, and of the present and probable future rates of consumption of these resources. The Committee will examine Governmental policies and laws affecting the fuels and energy industries to determine what, if any, changes may be advisable in order to provide an effective national fuels policy.

What new factor has emerged to provide the motivating force for this broad-scale study? Three major elements explain the heightened interest in this problem and the increasing desire to deal with it seriously.

1. National security. Fully two-thirds of all of the materials of war consumed in World War II consisted of petroleum and its products. With the increasing complexity of modern warfare, logistic problems have grown in geometric proportion. We may expect that problems of supply of energy resources, while critical in World War II and the Korean conflict, will be far more complex, in any future emergency. Constructive thought must assure that inadequate supplies will never limit our defense ability.

2. Dynamic nature of our energy-producing industries themselves. From an economy almost totally dependent upon animals and wood for its energy only 100 years ago, we have witnessed coal's growth to supremacy, the subsequent emergence of petroleum as the principle energy source, and the more recent development of natural gas into a major supplier. In the foreseeable future, nuclear energy, oil from shale, and oil from tar sands will enter the competition in a major way.

Intense competition has tended to increase availabilities of energy at reasonable prices and, therefore, has provided a further spur to our growth. At the same time, there have been social disruptions in the wake of this competition. The coal industry, for example, has been in some difficulties in recent years. Research efforts, if successful, could well change the structural nature of coal marketing, and place coal and its products more directly in competition with the liquid fuels.

3. The growing internationalization of energy resources development and use. The United States is becoming increasingly tied to its neighbors by a tangible web of transmission lines. These facilities are the physical tokens of the growing trend toward interdependence of nations in energy resources.

Today, energy consumption in the United States on a per capita basis is almost six times the level that prevails in the rest of the world.

As energy has become an increasingly important element in our economy, the actions of the Federal Government affecting energy have become increasingly important to our economic growth and development.

The Government is deeply involved in our energy economy. The trend has been for this involvement to increase. It is essential to assure that the effect of this increased participation of the Federal Government in energy matters is constructive, that the policies which guide the Government in its dealings in the energy sector contribute to, rather than retard, our growth. For these reasons the Department of the Interior favors the conduct of the fuels and energy study.

There was a time when we could, as a nation, sit back and let nature take its course in economic development. That time has passed. We live in an increasingly competitive world. Several things flow from that competition. We must be absolutely sure that our economic development is such that the United States remains the leading industrial nation of the world. We must keep ahead in the economic battle in which we are totally engaged. We cannot permit our policies in so important a sphere as energy to be anything less than the best. Each of the areas of Government interest that affects energy must be examined critically to determine whether or not it makes its maximum contribution.

EDITOR'S NOTE: This is a condensed version of Assistant Secretary Kelly's address before the New Mexico Oil and Gas Association.

■

Do We Need a Fuels Policy?

by W. C. Norman

The Senate Interior Committee is conducting a national fuels study and considering what legislation might be needed to implement a national fuels policy. One section adds that a policy should take "into account the investment of private enterprise for the maintenance of efficient and adequate fuels and necessary related industries and necessity for maintenance of an adequate force of skilled workers."

The proposed outline of study for the Committee fills eight pages, including such matters as: Taxes (depletion and depreciation), oil import tariffs, supervision of Interstate Oil Compact by Department of Justice, state government production controls, regulation of gas rates and services, balance between oil and gas prices, interruptible contract prices for natural gas, imports, etc. This sample gives you a glance at the enormous ramifications of such a study.

Establishment of a national fuels policy sounds like a noble goal — but how practical and how effective can it be? We have seen much simpler objectives, such as natural gas pricing or imports controls, bogged down by monumental administrative problems or by contradictory interpretations of regulatory agencies and the courts. Can any policy, subject to the whims of politics and the pressures of special interests, be a practical matter? The big danger is that instead of simplifying and consolidating all the laws and regulations affecting fuels, the government is likely to pile more and more regulations on top of those already existing. The fuels industry already is over-regulated by government.

You surely have observed that federal agencies do not die nor do they fade away — like old soldiers. The record is pretty clear that once an agency is born it breeds and multiplies more bureaus, more regulations, more forms, more reports and more everything.

If there were assurance a new national policy would bring together and simplify the multitude of regulations affecting all fuels industries, then it would have my unqualified support. But I fear, and certainly there is historical basis for such a fear, that we are likely to find ourselves with another superfederal agency pyramided on top of those already functioning.

Whether or not we take a position on the need for a national fuels policy, it is imperative that we resist any move toward end-use controls. They should be resisted simply because they are unnecessary in an economy that has an abundant supply of all fuels. And the preservation of a free competitive system will assure channeling these fuels into their most efficient uses.

All divisions of our industry are inseparably linked, yet at times there is a tendency for producers, refiners and marketers to act at cross purposes. Every one of us has the same objective.

The impression of instability created at the service station pump makes an unfavorable impression of industry. More than that, giveaway prices are destined to undermine the economic structure that supports everyone in the industry. This makes it imperative for us all to be concerned with marketing practices which are the foundation of a continuing healthy industry.

My hope is that our industry can work out its own problems without calling upon the federal government to end practices generated internally.

Everyone says he doesn't want the federal government to intervene on domestic issues in the industry. But actions of these same people, who continually warn of government intervention, seem to indicate that secretly they want some bureaucrat to step in and try to solve their problems. Certainly their actions do not jibe with the public pronouncements that they want no more help or supervision from government.

We need less government control. As Morgan J. Davis, Humble board chairman, testified before the Senate Interior Committee: "We have always had a national policy applicable to fuels and energy as well as to all other commodities. This policy is based on encouraging and preserving a dynamic, competitive private enterprise."

EDITOR'S NOTE: Abstracted from an address by Mr. Norman, president, Colorado Oil & Gas, before Rocky Mountain Oil & Gas Association. ■

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■ PIPELINES AND EQUIPMENT AGAINST CORROSION
■ PRODUCTS AGAINST CONTAMINATION

Here's a simple and inexpensive method to protect against corrosion in pipelines, storage tanks and process equipment . . . and eliminate a source of product contamination.

You can add Unicor at any point in your operation. You don't need to add much . . . only 10 to 20 parts in a million parts of petroleum distillates. This potent, oil-soluble additive then plates out a molecular film on the inner surfaces of pipelines, refinery vessels and tanks . . . provides lasting protection against corrosion . . . and safeguards the quality of your products against contamination.

This means important savings through reduced downtime for maintenance and cleaning . . . lower power costs . . . longer equipment life. Its consistent use assures full flow capacity and safeguards product purity.

Our Products Department will be happy to forward detailed information and samples on request. Or, if you wish, one of our field engineers will be happy to show you how Unicor can be best introduced in your operation for maximum effectiveness.

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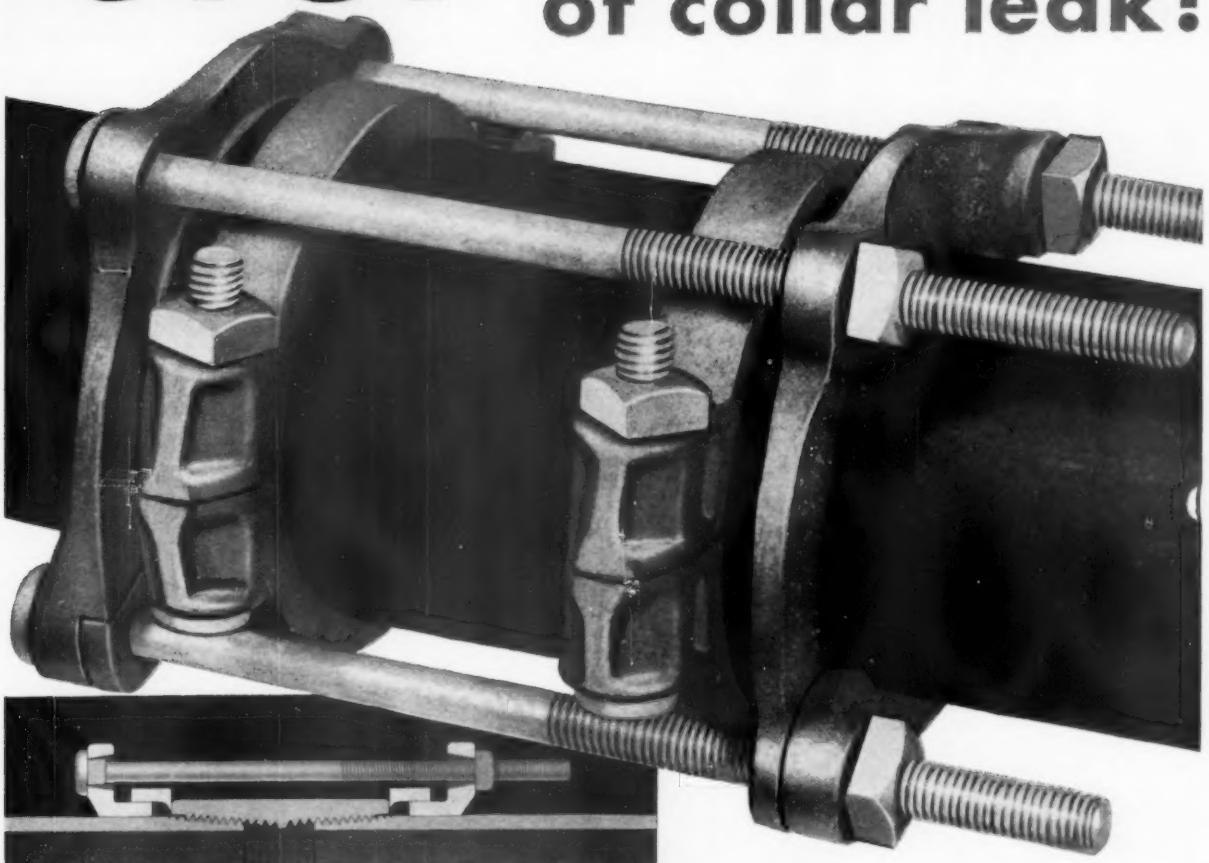
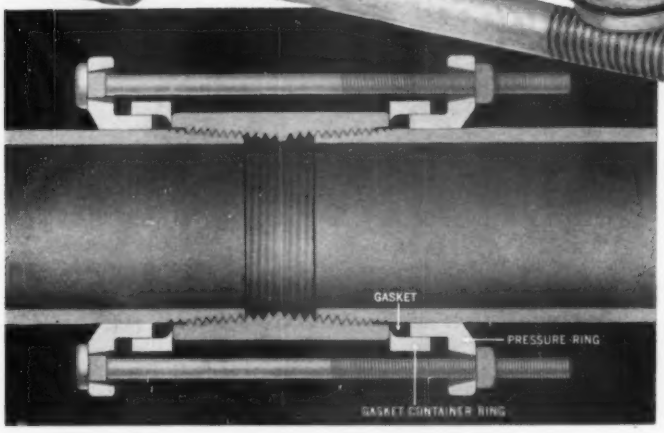
STOP every type of collar leak!





SKINNER-SEAL collar leak clamp with sealed gasket

SKINNER-SEAL Collar Leak Clamps are standard equipment with most companies, for permanent repairs on oil and gas lines. Gasket is sealed by gasket container rings — pressure is sealed in . . . air, moisture and gasket-destroying soil conditions are sealed out. The pipe, not the collar, guides the packing into the leak. Massive malleable iron rings, oversized, high tensile steel, electroplated bolts and rigid container rings give this Collar Leak Clamp extraordinarily long life. Sizes 2" — 12" inclusive in stock at supply stores!

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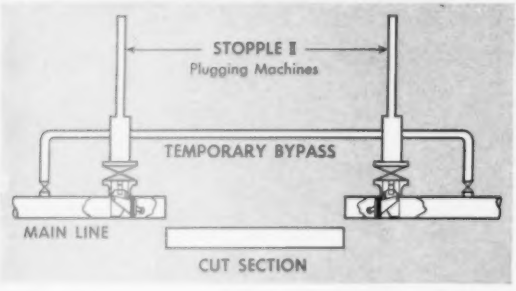
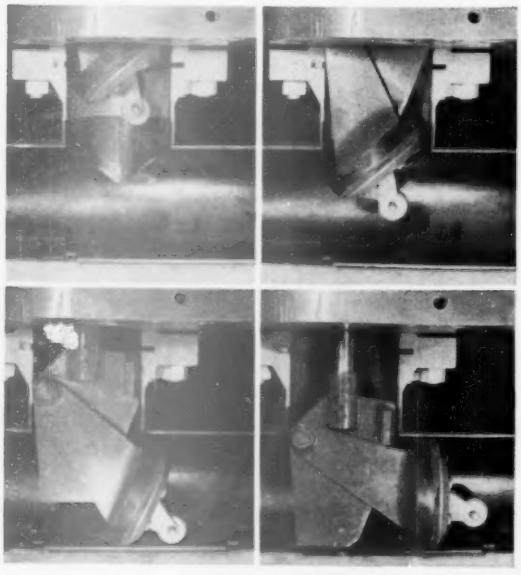


❶ "This method of plugging a line and bypassing the flow has been used extensively in plant and field operations with WMSon tapping and STOPPLE equipment. Many costly shutdowns have been avoided. Now, WMSon engineers have re-designed and improved the STOPPLE Plugging Machine. Result . . . the all new STOPPLE II . . . offering hydraulic operation, improved, simplified construction, and economy—**real** economy!"



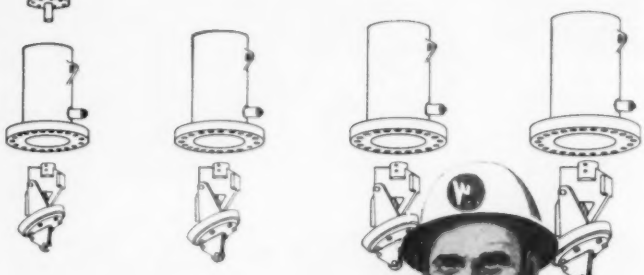
❸ "Here's how STOPPLE II works. After the tap is made, the STOPPLE II is mounted on a WMSon SANDWICH Tapping Valve, and the plugging head is lowered into the line, stopping the flow completely. New single link construction of the plugging head offers built-in simplicity . . . and strength for high pressure plugging."

NEWS FROM DOWN THE LINE!

NEW economy
NEW improved design
NEW interchangeable plugging heads . . .

WMSON'S ALL NEW STOPPLE® II

Plugging Machine for piping modification or repair WITHOUT SHUTDOWN!



❷ "Here's the major reason for this economy. The STOPPLE II has a hydraulic cylinder that is interchangeable with plugging heads of different sizes. For example, one hydraulic cylinder can be used on a 14", 16", 18" or 20" line by using it in combination with a plugging head and housing of the proper size."

•

WMSon STOPPLE II with hydraulic operation is available in sizes 8"–30". The 4" and 6" units are hand operated. Single link is standard in all sizes. Write for additional information and specifications: Write Dept. B for Bulletin A-513.

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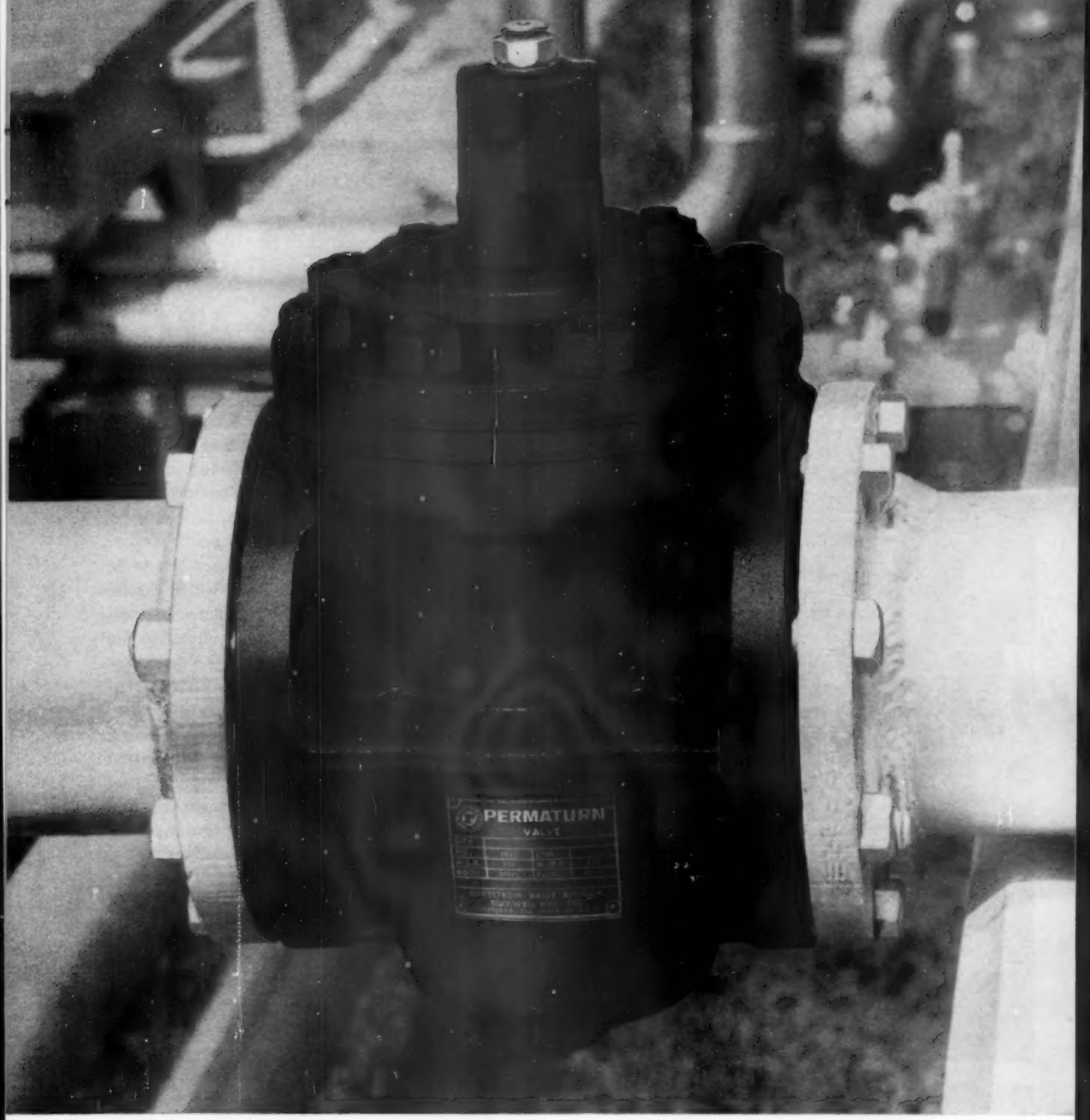

PERMATURN* **VALVES • so new, we changed their colors, too.** You'll find the new PERMATURN semi-steel valves bright red: a color just as bold as the design concept they represent. For Rockwell PERMATURN valves were designed to incorporate all the most-wanted valve features: to give you new valve versatility for easy services or tough ones. Steel PERMATURN valves are now gray and offer new standards of valve performance in the higher pressure services.

To learn more about this exciting new valve line, write to Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pennsylvania for a copy of the new Pocket Valve Guide.

PERMATURN VALVES
another fine product by
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*Trademark Rockwell Manufacturing Company

Improved Kellogg Techniques Provide Increased Creativity in New Plant Design . . .

1 Many of the computer programs in Kellogg's extensive library have been developed jointly by process engineering and computer specialists.

More efficient engineering and sounder new plant investments will result from use of a new high-speed IBM 7070 computer installed at The M. W. Kellogg Company's headquarters in New York.

The new computer and improved programming techniques mark another major stride in Kellogg's continuing improvement of its engineering services. Its speed makes practical rigorous calculation and the evaluation of multiple solutions to difficult design problems—a vital step in achieving the most economic design.

The computer's large capacity will enable Kellogg to develop new methods which can be applied to plant engineering problems. In addition, it will permit Kellogg to broaden its present activities in such areas as computer control, process dynamics, and systems engineering.

New engineering techniques and increased engineering efficiency are vital to the creation of optimum plants. If you are planning a new plant, Kellogg engineering services, more than ever, can help you achieve optimum plant design and a more economic investment.

2 Engineering data and computer commands, punched on cards and stored on magnetic tape, are read into the computer.

3 A printout provides engineering data ready for evaluation. Simplified methods permit ready use of computer for solving a wide range of process and mechanical design problems.

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Pumping unit value is only as good as the service that stands behind it. This is why Cabot maintains convenient 'Round the Clock service centers throughout the oil industry . . . service centers with complete stocks of Cabot parts and manned by factory trained personnel. This is your 24-hour-a-day guarantee that Cabot will deliver dependable pumping. CALL YOUR J&L MAN...

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FROM HALLIBURTON

Halliburton Fracturing Treatments Produced These Successful Results

Five Zones in Well Treated For Highest Pay in Field

Crane County, Texas. Five intervals were selectively acidized and fractured in this well and it potentialled some 170 BOPD more than other wells in the field. A Halliburton Retrievable Test-Treat-Squeeze (RTTS) Packer with Retrievable Cup-Type Bridge Plug isolated each zone successively during a single trip in the hole. Fluid loss during treatment was controlled. Here are the details:

INTERVAL	ACID TREATMENT	FRACTURE TREATMENT
1	4,000 gal. 15% N.E. Acid	25,000 gal. Waterfrac with gelled brine containing WLC-2 Fluid Loss Additive and 32,000 lbs. 20-40 sand. Injection rate: 31.4 bpm.
2	3,000 gal. 15% N.E. Acid	
3	3,000 gal. 15% N.E. Acid	10,000 gal. Waterfrac same as above with 13,000 lb. 20-40 sand. Injection rate: 25.5 bpm.
4 (Notch)	5,000 gal. 15% N.E. Acid	42,000 gal. Waterfrac same as above with 24,000 lbs. 20-40 sand and 4,300 lbs. rounded walnut hulls. Injection rate: 31.3 bpm.
5 (Notch)	5,000 gal. 15% N.E. Acid	

A Twin HT-400 fracturing unit and a Twin T-10 fracturing unit were used, together with a Model 45 Sand Proportioner. Results from the treatments were rewarding — 570 BOPD of 44.7 API gravity oil on a 32/64″ choke.

Multifrac Results in 317 BOPD Flowing Where 110 BOPD Usually Expected

Ward County, Texas. Adjoining wells in the same zone ordinarily produce about 110 BOPD, but a Sandoil multiple fracture treatment on a new well produced the exceptional results of 317 BOPD flowing initially, and 305 BOPD flowing after one month. One perforation was made in each of the three zones. During the fracturing job the number of perforations actually taking fluid were calculated from friction data and formation pressures, then Perfpac balls were injected, one for each zone, when needed. This resulted in the effective treatment of all three zones and apparently reached one that was not treated in the other wells. Fracturing fluid used was 6,000 gal. of refined oil with 9,000 lb. of 20-40 sand. Three Twin T-10 fracturing units, a Proportioner, and a Fracometer were used in the treatment.

Successful Test Run On Aluminum Pellet Evaluation

Uintah, Utah. This job was run to evaluate aluminum pellets as a propping agent in this area. A horizontal, 360° Halliburton Hydra-Jet notch initiated the treatment on a new well in the Green River formation. To increase production from a meager show, a Sandoil treatment was run consisting of 13,440 gallons of No. 5 fuel oil and Rangely shale oil in 50/50 proportions. Sand totaling 2,500 lb. was run at ½ lb. per gallon and followed with 12-16 aluminum pellets at .25 lb. per gal. and then increased to .3 lb. per gal. The treatment was completed with 8-12 pellets run at .35 lb. per gal. The well responded with increased production immediately, and after two months, was producing 250 BOPD and 200 BWPD. The actual maximum production is unknown, but this is one of the better wells on the lease.

Aluminum Pellet Tail-In Increases Pay Over Offset

Stephens County, Oklahoma. An old well in the Springer formation from 5,396 to 5,418 ft. was producing 145 BOPD. The operator decided upon a treatment similar to that performed on an offset well, but tailing-in with aluminum pellets. Fracturing fluid consisted of 20,000 gal. of 9.2 lb. per gal. salt water containing a low fluid loss additive. Propping agent was 18,800 lb. of 20-40 sand followed by 1,600 lb. of 12-16 aluminum pellets. Equipment used on the job included two Twin HT-400 fracturing units and a Model 70 Proportioner. A Halliburton Fracometer continuously recorded progress of the treatment. The well responded with production of 251 BOPD, an increase of 106 BOPD.

THESE AND MANY OTHER advanced fracturing techniques are available for your wells. Your Halliburton representative will be glad to discuss them with you.

First and Foremost in Formation Fracturing

FRACTURING SERVICES

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Things To Come

IMPORTS DUE REVAMP

The new imports quota period coming up Jan. 1 will incorporate some rather drastic revisions. Secretary of Interior Stewart Udall has recommended a 50,000-bbl daily cut in incoming foreign crude and has pointed an accusing finger at what he terms a "loophole" existing in California. Crude shipped to the east from California can be replaced by imports on a "need" basis. Udall has also expressed concern over rising crude shipments from Canada which, he says, have "gone much faster than we anticipated."

IPAA SEES DEMAND UP

The Supply and Demand Committee of the IPAA sees a small, but firm, increase in demand for crude oil products, forecasting a 1961 demand of 9,797,000 bbl per day, up 1.2% from 1960. Domestic demand next year will be 10,070,000 bpd, 2.8% over the 1961 level.

LOGS TAKE TO AIR

Telemetering downhole electric logs from field to a central office for quick analysis and decision is just around the corner and can be made available as soon as sufficient demands warrant. Success in recording logs on magnetic tape in the field makes it a relatively simple step to transmit the log over long distances from the field to central printout and computer analysis points. Dipmeter logs have been analyzed by computers for more than a year with successful results. Advent of the magnetic tape recording opens up almost unlimited horizons in the well-logging field.

CREW HOURS CUT

Drillers will work a shorter week following the pattern set in the Permian Basin. Although most of the area's rigs are still operating with a 56-hr driller workweek, more contractors will join the trend to 48-hr and 42-hr weeks. Take-home pay for the shorter weeks will be maintained with wage boosts.

GAS PRICES TO CLIMB

"Under any reasonable assessment of the future, it must be concluded that a substantial increase in the average well-head price of natural gas is mandatory," says Ira H. Cram, executive committee chairman, Continental Oil Co. Cram cited increased drilling costs, deeper wells with more expensive completion costs and skyrocketing demand as the basic reasons for an inevitable boost in gas prices.

McCULLOUGH SALINITY LOG

with scintillometer®

...a nuclear log that tells

OIL *from* SALT WATER

The McCullough Salinity Log determines the presence and degree of saline fluids in formations surrounding the bore-hole. It will distinguish between oil and salt water and can be used in open or cased hole. Providing hole diameter is not extreme, it may be used where air or gas or highly saline fluid was used for drilling.

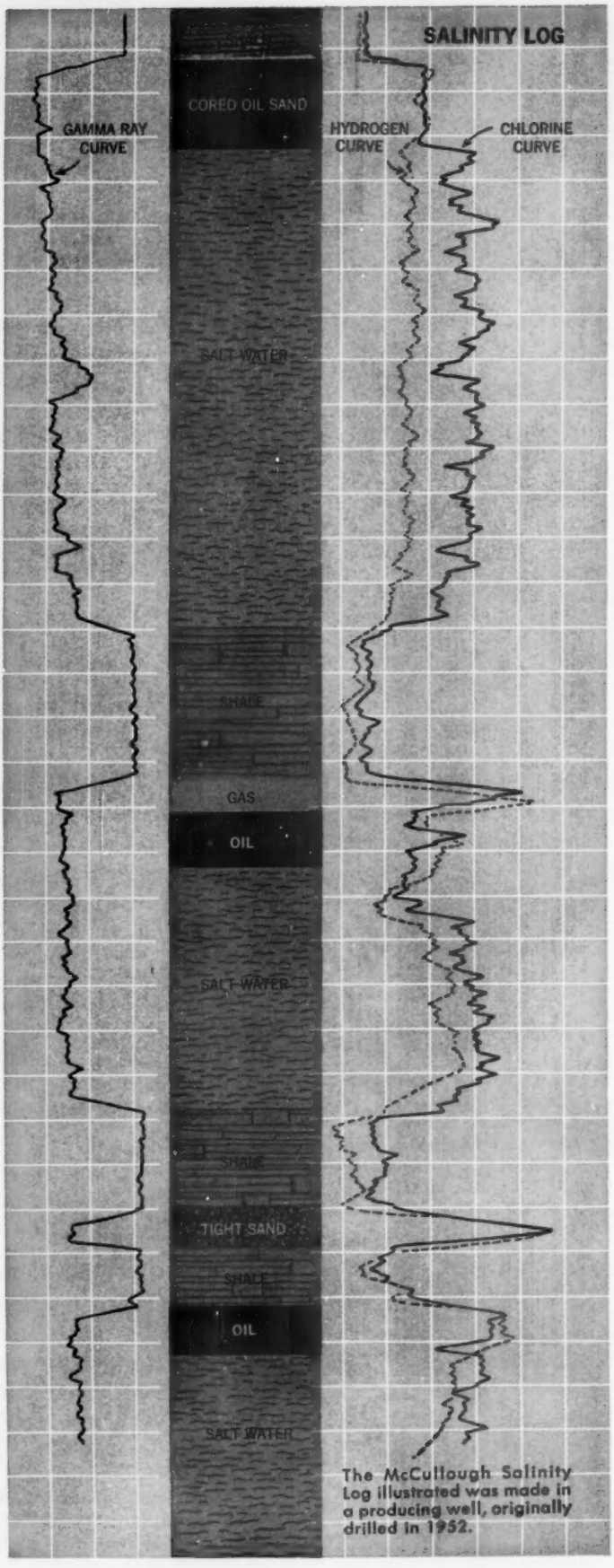
A "chlorine" curve and a "hydrogen" curve are recorded simultaneously at the same depth elevation with a single detector. These curves are compared to indicate the amount of salt, NaCl in particular, that is present in the formations being investigated. In potential oil bearing formations the absence of salt is indicative of the presence of oil.

The recording of the two curves simultaneously is considered essential. It eliminates the possibility of a depth discrepancy between two curves which are recorded separately. It also insures the recording of information under identical physical conditions—of extreme importance in interpreting the two curves.

A higher counting rate and greater instrument efficiency allows an increased spacing (23½ in.) between the source and the Scintillometer. This provides the added benefit of a proportionately larger zone of investigation.

Take a look at these features:

- **Distinguishes between salt water and oil in liquid bearing formations.**
- **Determines the degree of salinity in formation fluid.**
- **Identifies salt water zones that must be blanked off.**
- **Makes possible water saturation calculations for potential oil bearing zones.**
- **Shows salt water and oil zone contact under suitable conditions.**
- **Aids in determining gas/oil contact.**
- **Helps determine if it is economically practical to set casing on new completions.**
- **Aids in evaluating correct depth to set casing string.**
- **Accurately re-evaluates old wells to locate potential cased-off production.**
- **A reliable tool for porosity determination.**



The McCullough Salinity Log illustrated was made in a producing well, originally drilled in 1952.

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another
TRETOLITE SERVICE
report

How TRETOLITE RESEARCH *has paid off*
...in more-salable oil at lower treating cost

It was intensive research that led to the founding of the Tretolite Company in the first place. And a program of continuous research has been at the very core of Tretolite operations ever since . . . and has resulted in the development of the very best and most efficient treating chemicals available anywhere.

THE CASE FOR TRET-O-LITE DEMULSIFIERS

To see what Tretolite research has meant to the producer, let's look at a few then-and-now facts concerning TRET-O-LITE* Chemical Demulsifiers:

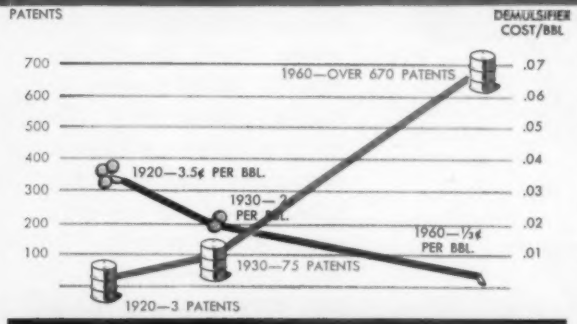
Needless Waste Stopped. Prior to the Tretolite discovery, literally millions of barrels of emulsified crude were thrown away—unusable, unrefinable.

Effectiveness Improved. In the beginning, one drum of demulsifying chemical was needed to recover about 2200 barrels of pipeline oil. Today, one drum will recover nearly 40,000 barrels.

BS&W Specs Reduced. Until 1930, "pipeline specification" for crude was about 3% BS&W. Today, the acceptable maximum is less than 1%—a trend due in large part to the constant improvement of modern demulsifiers.

Drastic Cut In Treatment Costs. In the 1920's, demulsification costs were around 2 to 3.5 *cents* per barrel. Today, in most areas, they are around 2 to 3 *mills* per barrel.

OVER 670 REASONS WHY *IT COSTS YOU* **LESS** *TO GET* **MORE** *SALABLE OIL TODAY!*



Tretolite had just 3 demulsification patents in 1920. By 1930, the number had increased to 75. Today, the Petrolite Corporation, of which Tretolite is a division, holds nearly 700 demulsification patents—nearly 700 reasons why it costs you less than ever before in oil history to treat oil, and provides you with a better, more salable product.

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T-60-2

40 GROVE G-5 GATE VALVES USED IN SHELL'S MANIFOLD MODERNIZATION

One of four Shell oil-gas gathering system manifolds at Gibson, La. Forty 3" Grove G-5 ASA series 150 Seal-"O"-Ring Gate Valves.

In modernizing its Gibson, La., oil-gas gathering system manifolds, Shell Oil purchased Grove series G-5 gate valves. These valves feature Grove Seal-"O"-Ring® design—the "double-barrier" sealing system. First, there's positive metal-to-metal seal of inner seat rings against a parallel sided gate. Second, the sealing and squeegee action of protected o-rings that keep the gate clean and smooth for fast, easy open and close. Other G-5 features: extremely compact, round opening, kanigan coating to resist corrosion. And the big plus: Grove G-5 gate valves eliminate all maintenance costs relative to lubrication!

Call or write for a complete Grove G-5 valve presentation

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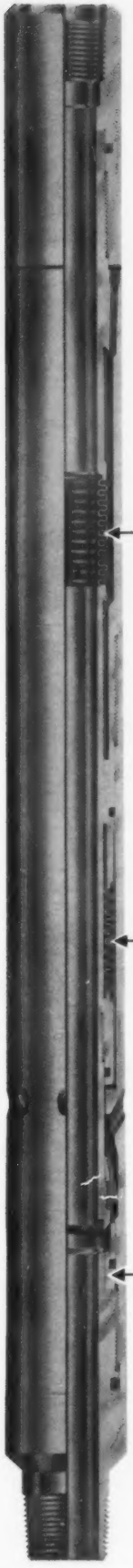

ANOTHER CAMCO FIRST...

Concentric Metal Bellows
Valve utilizes Tubing
Pressure Effect...
Outperforms, outlasts
Rubber Diaphragm Valves

Camco E Concentric Valve

Camco presents an entirely new Gas Lift Valve—The Type E Concentric Valve, first and only valve to employ **concentric metal bellows**—which provides versatility and superior performance not previously obtainable in small-annulus gas lift.

The unique dual-bellows design of the E Concentric Valve gives you the invaluable advantage of **tubing pressure effect** to aid in opening by minimizing pressure drop between valves—a feature not available in a rubber-diaphragm type concentric valve.

Another distinct advantage is the **versatility** obtained by simply changing the readily removable seat to one of greater or less area, permitting the E Concentric Valve to be operated across a range of pressure effects from full casing pressure operation to full tubing pressure operation.

Unlike a rubber valve element, the rugged **3-ply monel Camco bellows** are not subject to deterioration caused by well fluids, thus providing far more positive opening and closing pressure control and much longer operating life.

This new valve is ideally suited for both continuous and intermittent flow. Its tensile strength exceeds that of 1¼″ Upset N-80 Tubing. Its ID permits passage of 1″ OD equipment, and its OD of 1.859″ permits the valve to pass through equipment of permanent completion ID.

The E Concentric Valve can mean greatly increased efficiency in your small-annulus gas lifting. Why not call the Camco man for details? Or write

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CAMCO, INCORPORATED

Box 14484, Houston 21, Texas

CAMCO, LIMITED, Belfast, U.K.

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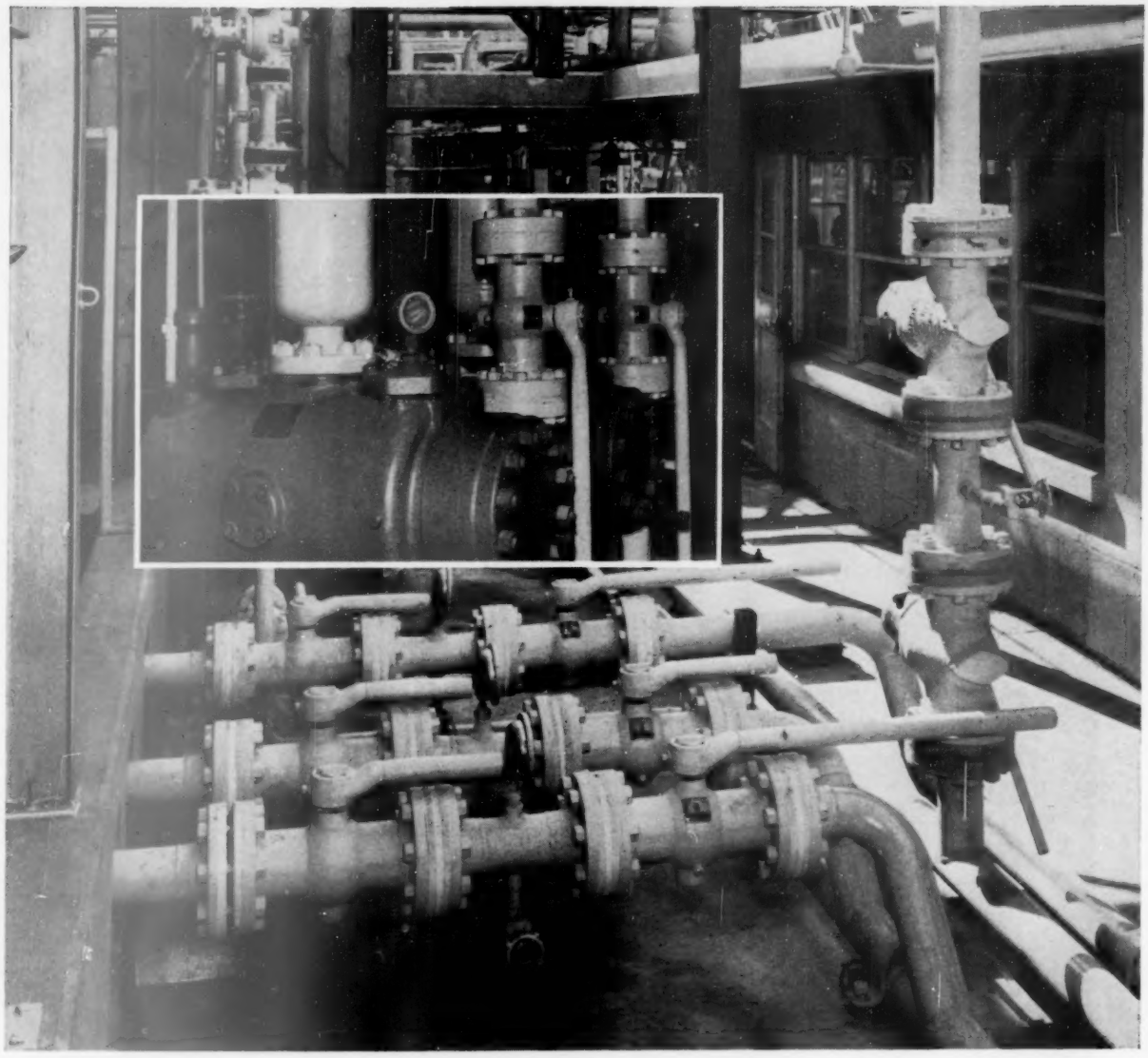


TAILORED TO FIT YOUR NEEDS

Cameron Ball Valves can be made of materials best suited to your needs, whether your problem is the handling of acids, alkalies or abrasives. Cameron's unique method of fabrication permits the use of exotic materials.

Lack of lubrication prevents product contamination. Teflon bushings, suitable for most applications, eliminate friction in valve operation. A tight shut-off for a long, long time is assured by a slight rotation of the seats with each valve operation. "Sealed for life" construction eliminates maintenance expense.

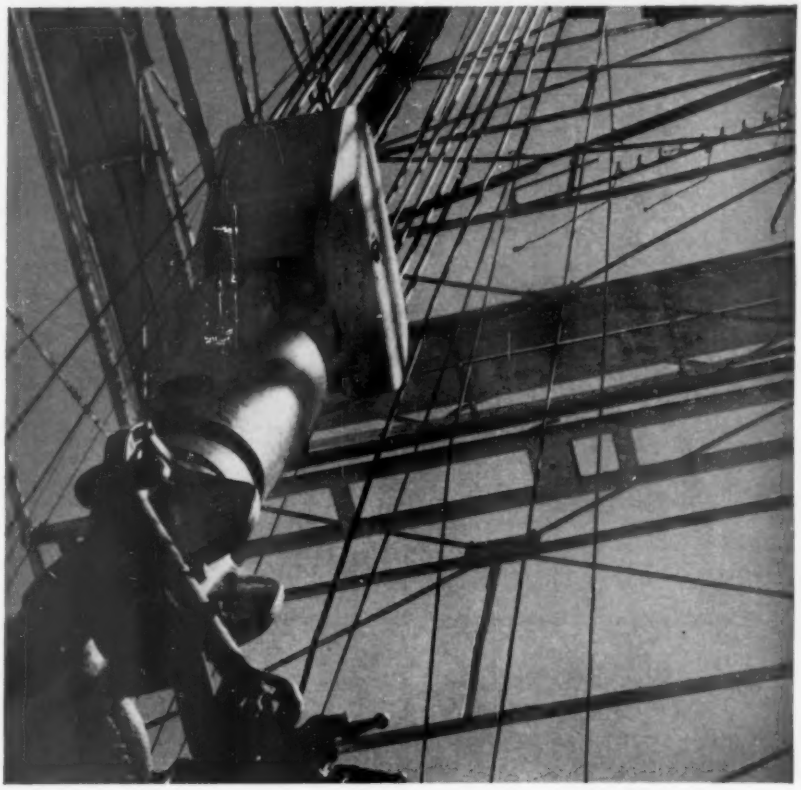
Cameron can make prompt delivery of Ball Valves from 2" to 42" (and larger if desired) in ratings of 150 lb. ASA to 1500 lb. ASA in any end preparation desired and of material to suit your needs. Let the Cameron representative furnish you details.

Cameron

CAMERON IRON WORKS, INC.
P. O. BOX 1212 HOUSTON, TEXAS

What is more important for efficient, economical drilling and completion than your mud and cement programs?

Rig up for Lower Cost Drilling and Completion... with DRISCOSE* and DIACEL**



Let us give you the benefit of experience gained over many years on thousands of wells. **Drilling muds and cement systems are our only business.**

Profit from the continuing development work done in our laboratories as well as from the assistance of our experienced field engineers. Our knowledge of up-to-date techniques can help you keep drilling and completion costs at a minimum.

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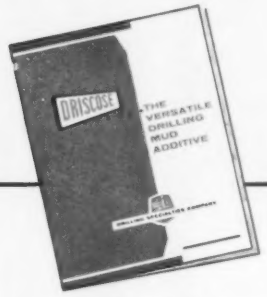


Technical Literature

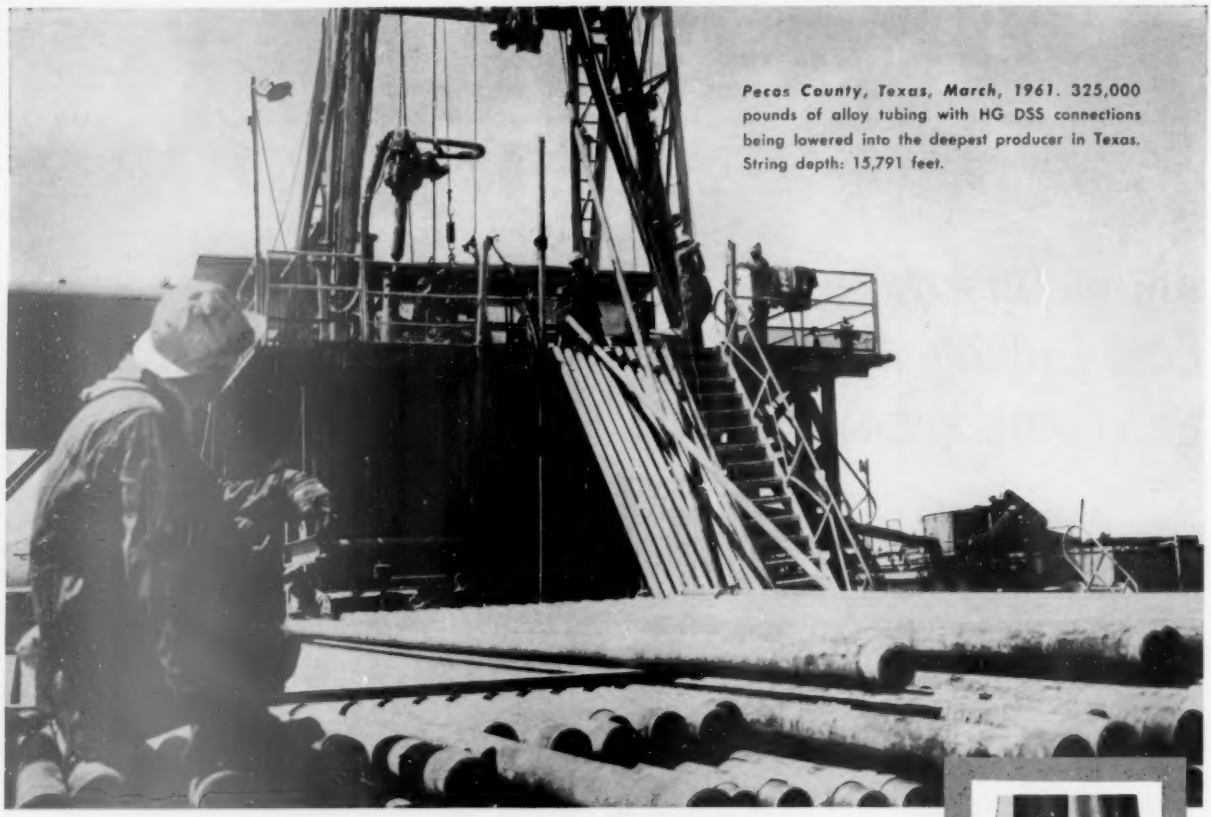
Driscose . . . The Versatile Drilling Mud Additive—A complete survey on Driscose High-Purity Mud Additives. Up-to-date information on the latest mud techniques. Write for your copy of this bulletin, D-20, today.

Also, complete DIACEL cementing literature, data and technical reprints are available.

**A trademark

*Driscose is a trademark for Sodium Carboxymethylcellulose

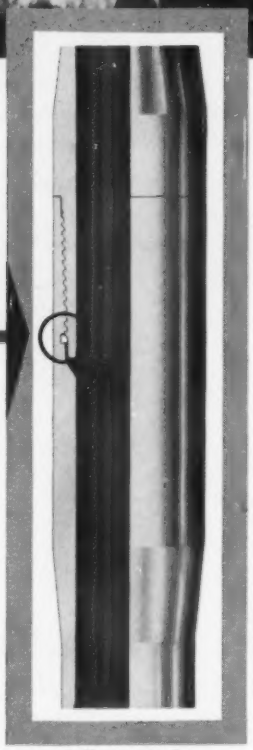
DRILLING SPECIALTIES COMPANY
Bartlesville, Oklahoma



Pecos County, Texas, March, 1961. 325,000 pounds of alloy tubing with HG DSS connections being lowered into the deepest producer in Texas. String depth: 15,791 feet.

USED IN TEXAS' DEEPEST PRODUCER

HG DSS TUBING CONNECTIONS



TEFLON SEAL

Streamlined HG DSS joints are installed in Atlantic Refining Company's No. 1 J. C. Kelly well in Pecos County—the deepest producer in Texas. This combination of rugged design and Teflon* seal has earned the confidence of engineers using this connection. The seal, unaffected by temperatures to 500°F, prevents seepage of the most difficult gases. Chipping of plastic coating is avoided by the unique joint design and the placement of the Teflon ring.

For deep-well, high-pressure applications, specify HG DSS tubing connections. For less critical applications use the economical HG DS. To leakproof your API threaded joints, get HG GT-API dual seal couplings. Write for descriptive literature.

All HG connections available in Europe through Stewarts and Lloyds Ltd. (England) and Comptoir F.B.T. (France).

• indicates coating

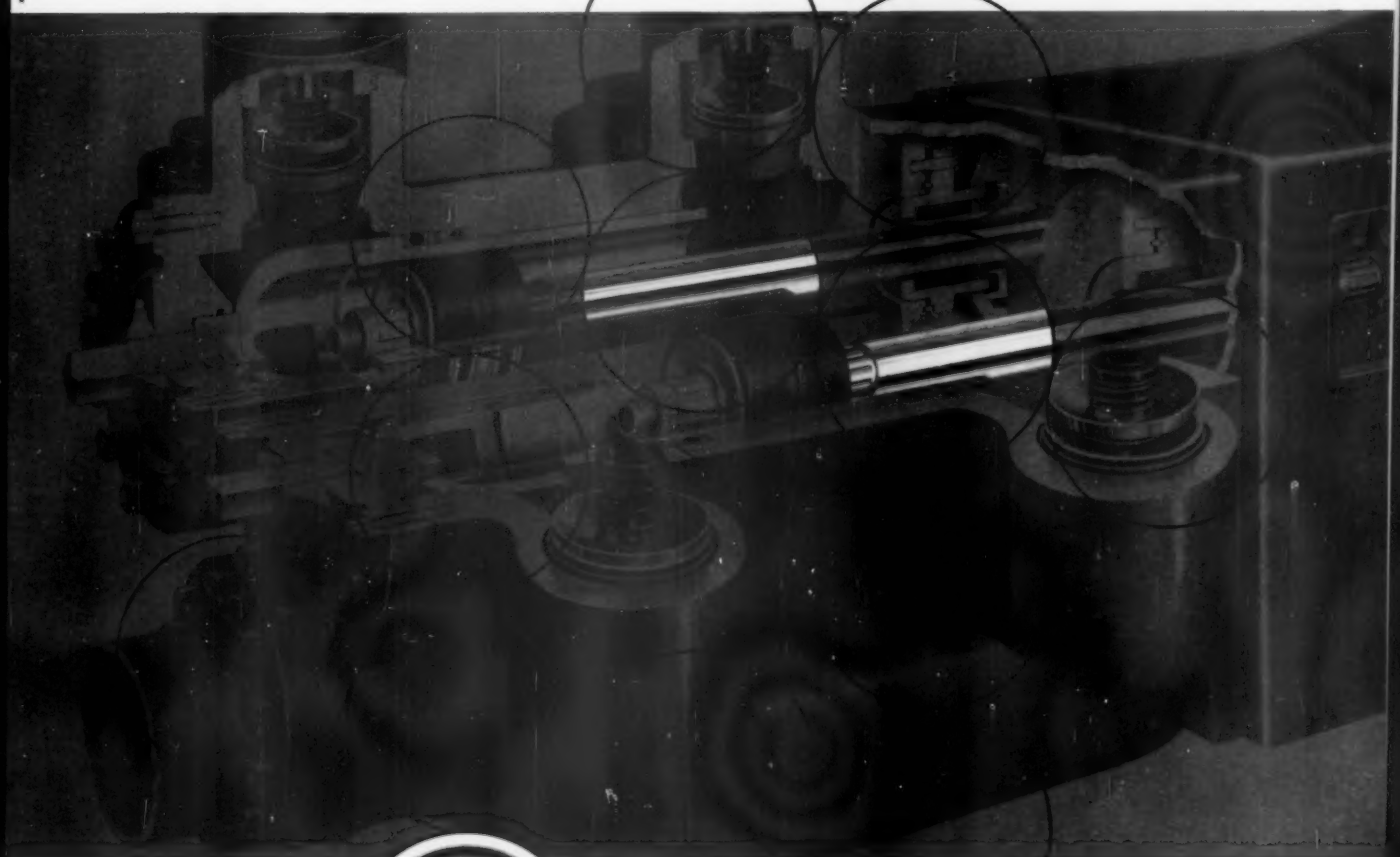
ATLAS BRADFORD COMPANY

General Offices: 3600 Yoakum Blvd., Houston 6, Texas
Export Office: P. O. Box 66669 • Cable: APINC—Houston

Formerly: Atlas Pipe Inc. / Bradford Supply Company / Hardy-Griffin Engineering Corp. / Universal Inspection & Service Co.

*Registered trademark of E. I. Du Pont Co. for their fluorocarbon resins including TFE resins.

Mission rods are here to stay



because Mission Super-Chrome rods have 2 wearing surfaces

Ordinary rods must fight corrosion fatigue as well as the fatigue from tensile and compressive stresses. But, the tough, hard-chrome plating you see in the photograph protects Mission Super-Chrome® rods against corrosion fatigue. That's one more reason Mission rods last longer. Beneath the coat of heavy chrome you can see the deep, file-hard case. Inside is the tough, high strength core. Its unusually high ductility will resist the fatigue induced by literally millions of tension and compression cycles, while the chrome plating resists the corrosion fatigue which could be induced by millions of gallons of drilling fluid. Mission Super-Chrome rods are sure to stay in your pump longer than any others. Specify Mission parts all the way and save all the way.

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Metered ACT and LACT systems are in your best interests. They provide printed records for proof of conservation control. They lower your operating costs. They verify all quantities transferred. And metered systems provide reliable records for billing purposes as well as firm facts upon which to base royalty and tax obligations.

Rockwell meter systems combine *all* the components you need for protection and savings on your lease. Rockwell meters have an all-revolving measuring mechanism which turns freely on anti-friction bearings without metal-to-metal contact. Rockwell air eliminators insure accurate measurement of liquid volume by removing all entrapped vapors. Automatic temperature compensators translate metered measurement to a uniform base temperature. Ticket printing registers simplify your accounting. Electric impulse contactors actuate remote counters and/or control solenoid valves or pumps for automatic shut-off.

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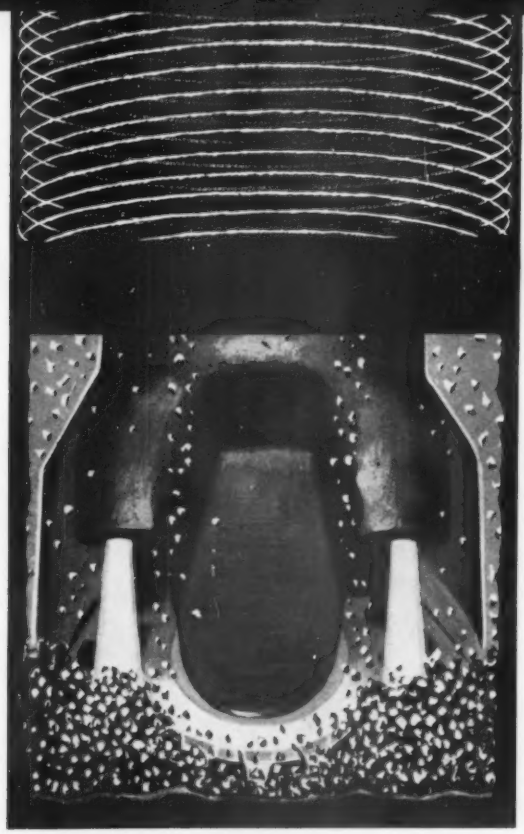
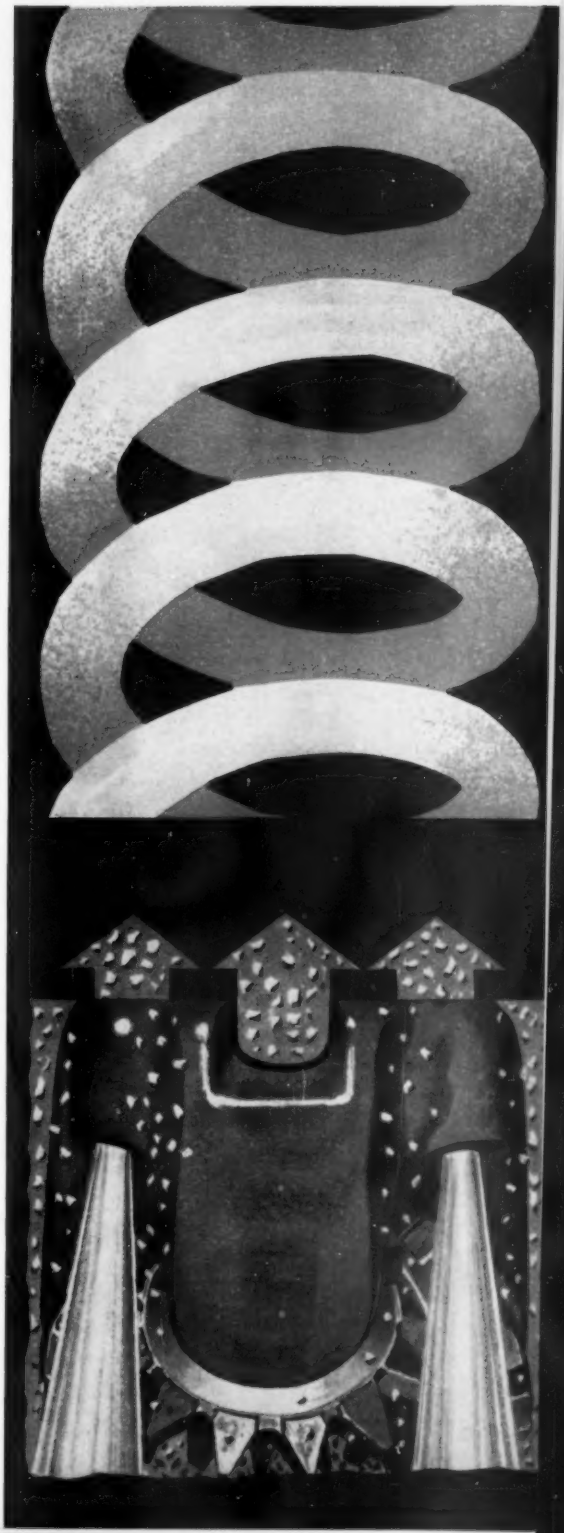
OIL FIELD METER SYSTEMS

another fine product by

ROCKWELL



milling or drilling?



How can you tell if you're milling or drilling? It's easy. If you are using Reed Flush-Flo jet bits you **know** you're drilling ahead. Here's why—

1—The Flush-Flo ports allow an alternate route around the high velocity jets. Laboratory tests prove the Flush-Flo design allows the drilling fluid to sweep the entire bottom of the hole, whereas other jet type bits develop little fluid movement at the center.

2—Jet bits without Flush-Flo ports require all cuttings and circulating fluid to return past the high velocity discharge jets. Flush-Flo design provides up to 50% more return area, prevents re-circulating of cuttings, balling and re-drilling cuttings.

3—The Flush-Flo ports minimize hydrostatic pressure on the formation when running in the hole and minimize swabbing when pulling the string. These two factors afford maximum protection and minimum mud bills when drilling in lost circulation areas and leave wall cake and walls in better condition.

4—The flow pattern of the Flush-Flo jet bit provides less turbulence at the bit and affords greater protection in very soft formations.

The Flush-Flo design is an exclusive from the Reed research team—the most significant development since the advent of jet bits. The place to look for progress in drilling tools is right here at REED.

REED

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Reed Roller Bit Company, Houston 1, Texas • Export Office: Time and Life Bldg., Suite 3744 Rockefeller Center, New York 20, N.Y.

121,000 gallons of hydrochloric acid couldn't chew up

Devonian Well Service of Odessa, Texas, put a new USS Tiger Brand PETROFIBER Core swabbing line into service in April, 1960. It was used intermittently and stored for a period of 11 months. Then came the big job. The unit that works this line was set over a 17,300-foot well in Pecos County, Texas, where it had to swab continuously for four weeks through 3½" drill pipe.

During this time, it went down to 13,500 feet and handled—

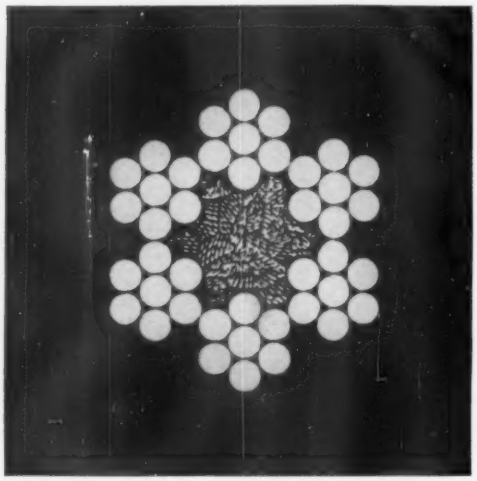
- **121,000 gallons of 15% hydrochloric acid, all preheated to 180°F., pumped into the formation and then swabbed back immediately. Bottom-hole temperature was 280°F.**
- **145,000 gallons of gelled water and 80,000 pounds of frac sand.**

This combination of preheated acid and swabbing back frac sand added up to about the most corrosive conditions to which a swabbing line core ever could be exposed. There was also a very heavy tensile loading upon the line.

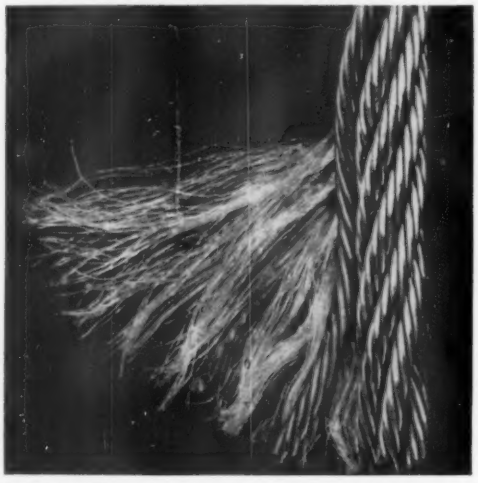
A close inspection of the rope after this 12-month workout showed that the entire swabbing line was in good condition. The PETROFIBER Core, in particular, showed no signs of acid attack and was still offering good support for the strands. A breaking test performed on a sample from the rope showed that it still had 92% of its catalog strength.

Dick McManigle, owner of Devonian Well Service, says, "Only a PETROFIBER Core line could take such a workout."

Order PETROFIBER lines from your distributor or write American Steel and Wire, Dept. 1466, Rockefeller Building, Cleveland 13, Ohio. USS, Tiger Brand and PETROFIBER are registered trademarks.



USS Tiger Brand Lines with PETROFIBER Cores are made in standard constructions, 6 x 7 and 6 x 19 in all sizes.



PETROFIBER line core broomed out shows appearance of core before being put into service.

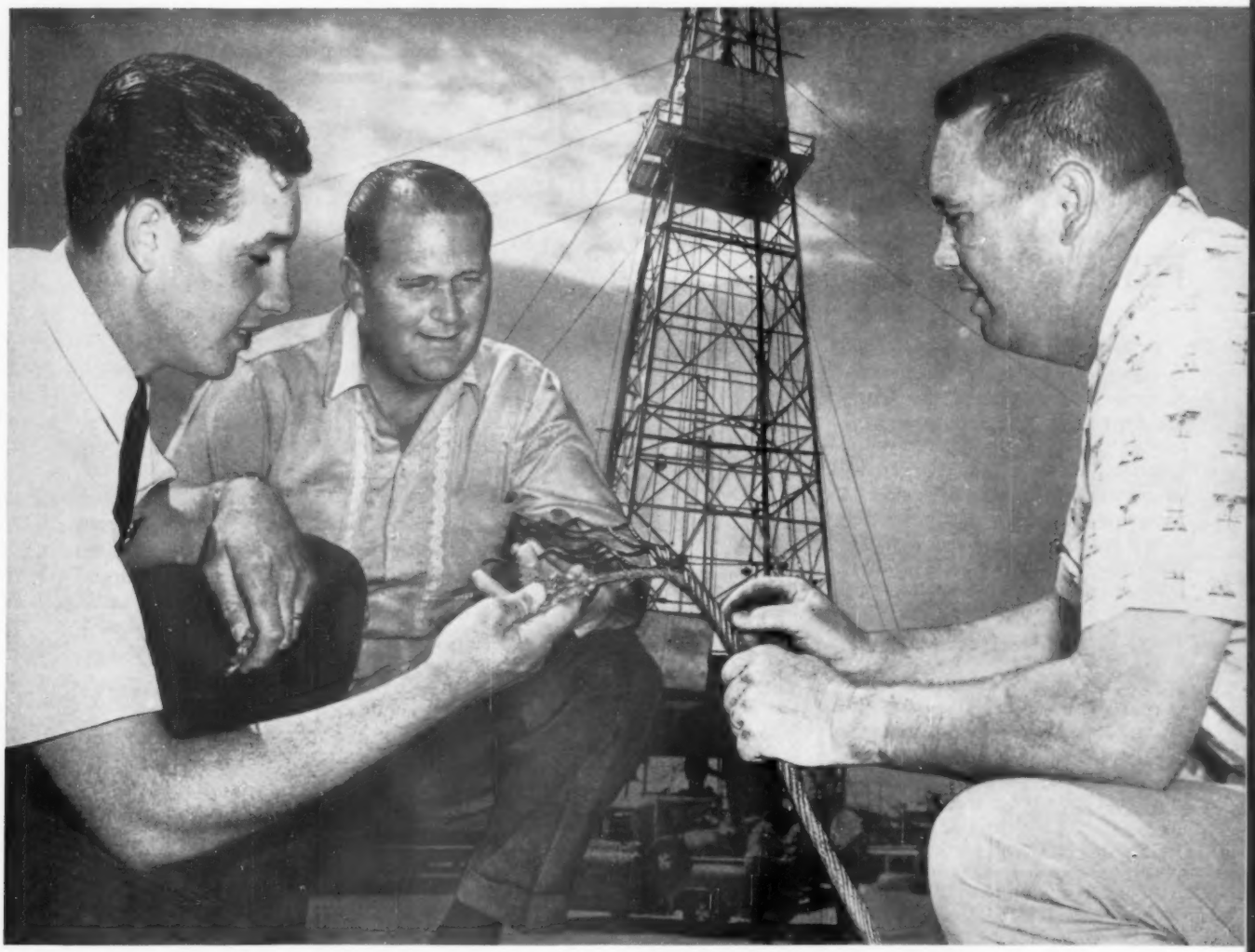
Advantages of Tiger Brand lines with PETROFIBER Cores

100% resistance to all hole fluids
A more stable line throughout its life
Withstands temperatures ranging from —80°F. to 300°F.
Long life and lower wire rope costs

American Steel and Wire
Division of
United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Export Company, Distributors Abroad

this PETROFIBER Core Line



Condition of $^{9}/_{16}$" 6x7 PETROFIBER Core line after a year of work in deep wells is checked by Dick McManigle, Jr. and Pat Patton of Devonian Well Service and Bill Campbell, American Steel and Wire sales representative in West Texas.

This mark tells you a product is made of modern, dependable Steel.

SPECIAL REPORT TO MANAGEMENT

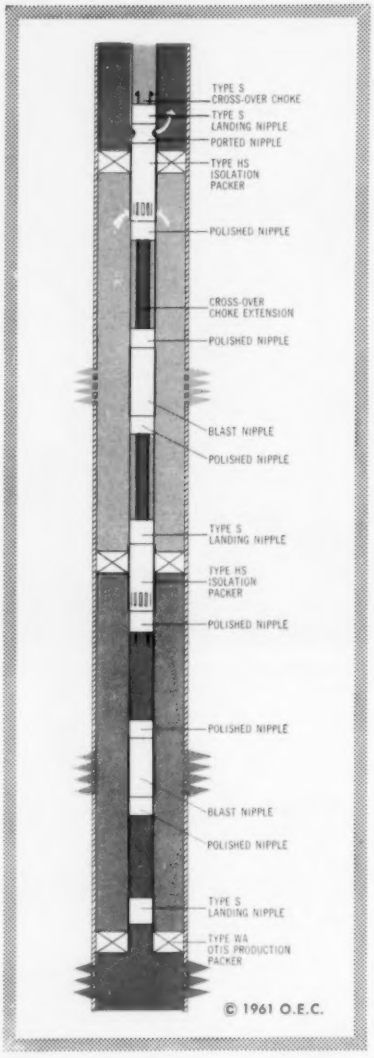
OTIS PRODUCTION NEWS

Volume II, Number 4 **Otis Engineering Corporation • Dallas** *Production Equipment and Services*

Otis Triple Zone Selective Cross-Over Completion Designed to Permit Production of Any Two Zones—Postpone Remedial Work

CORPUS CHRISTI—Operators in this area have found a new Otis Selective Cross-Over Completion ideal for producing new triple zone wells. The completion offers its greatest savings through selectivity of production, and is designed to postpone remedial operations which would entail moving a rig back over the hole. The completion is also designed to be made in standard 5½" casing using 2⅜" tubing to aid in holding downhole equipment costs to a minimum. This new Otis triple zone completion is designed to permit any one of the three zones to be produced individually with the other two blanked off, or two of the three zones to be produced simultaneously, directing the production from either zone through the annulus or the tubing as desired. When producing two of the zones simultaneously, one of the zones must be crossed-over just above the top packer through the use of a standard Otis Concentric Cross-Over Choke.

In addition to the above, this type of cross-over completion offers several other production advantages. The completion technique employed on initial installation is designed to permit each packer to be tested to the breakdown pressure of the zones before the next packer is set. Access to the upper zones is through the ports in the Sliding Side-Door® assembly of the Type HS Otis Retrievable Isolation Packer. Type HS Packers are used to isolate the upper two zones as shown in the accompanying installation diagram. In this installation, by straddling the upper zone with the top two packers, a short extension to the Otis Straight Flow or Cross-Over Choke acts to permit selective production of the middle and lower zones or the middle and upper zones through the tubing or annulus, with the alternate zone blanked off in each case. This also serves to permit chokes to be changed by standard wire line methods without requiring a rig over the hole.



In addition to these advantages, the completion technique is designed to permit any one of the zones to be exposed to the tubing or the casing, or both, with the other two zones blanked off for circulating, treating, and testing. Fracturing treatments on individual zones at pressures up to 4,500 p.s.i. have been performed in wells using this type of completion.

This is another Otis-engineered completion designed to provide the ultimate in economical, versatile, and efficient alternate-zone selective production. For more information on alternate-zone, selective and multiple completions, or for help with any other specific completion problem, call the Otis office nearest you or write Otis, Dept. 4-W, P.O. Box 35206, Dallas 35, Texas. You'll find your Otis Well Completion Specialists ready to help you . . . anxious to serve you.

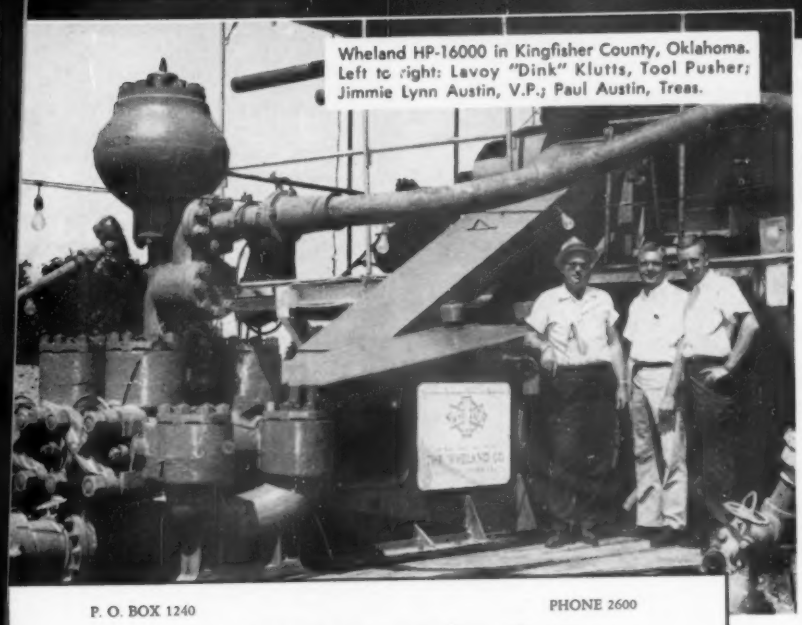
OTIS

Engineering Corporation

General Offices:

6612 Denton Drive • Dallas, Texas

Only WHELAND
combines these features:



Wheland HP-16000 in Kingfisher County, Oklahoma. Left to right: Lavoy "Dink" Klutts, Tool Pusher; Jimmie Lynn Austin, V.P.; Paul Austin, Treas.

Planetary Gears
Oversize Bearings
Big Gear Reduction
Small Sheave
and Cylindrical
Crossheads

P. O. BOX 1240 PHONE 2600

Jimmie Austin & Sons, Inc.

Seminole, Oklahoma

August 1, 1961

Mr. Gordon P. Street, President
The Wheland Products
Division of Gordon Street, Inc.
Chattanooga, Tennessee

Dear Mr. Street:

As you know, we have used Wheland pumps for many years. From our own experience we became convinced that the Wheland HP-14000 Pump couldn't be beat.

But your planetary HP-16000 Pump is so quiet and smooth running that we are digging more hole faster and at less cost. Part of the increased penetration comes from the fact that the HP-16000 is bigger than the HP-14000. But that is only part of the story.

The new planetary gears let us use a much smaller sheave. The cylindrical crossheads, oversize bearings and the big gear reduction make the pump easier to pull, run smoother, and do a better job.

We have used this pump in Kingfisher County, Oklahoma, and find it just right for this area.

Yours very truly,

JIMMIE AUSTIN & SONS, INC.

By Jimmie Austin
President

JA:rmm

WHELAND PLANETARY

HP-16000

Duplex Power Slush Pump
7¾" x 16", 600 H.P. at 65 RPM

WHELAND

ROTARY DRILLING MACHINERY

THE WHELAND PRODUCTS
DIVISION OF GORDON STREET, INC.
CHATTANOOGA, TENNESSEE, U.S.A.

DRAWWORKS • SLUSH PUMPS • ROTARIES
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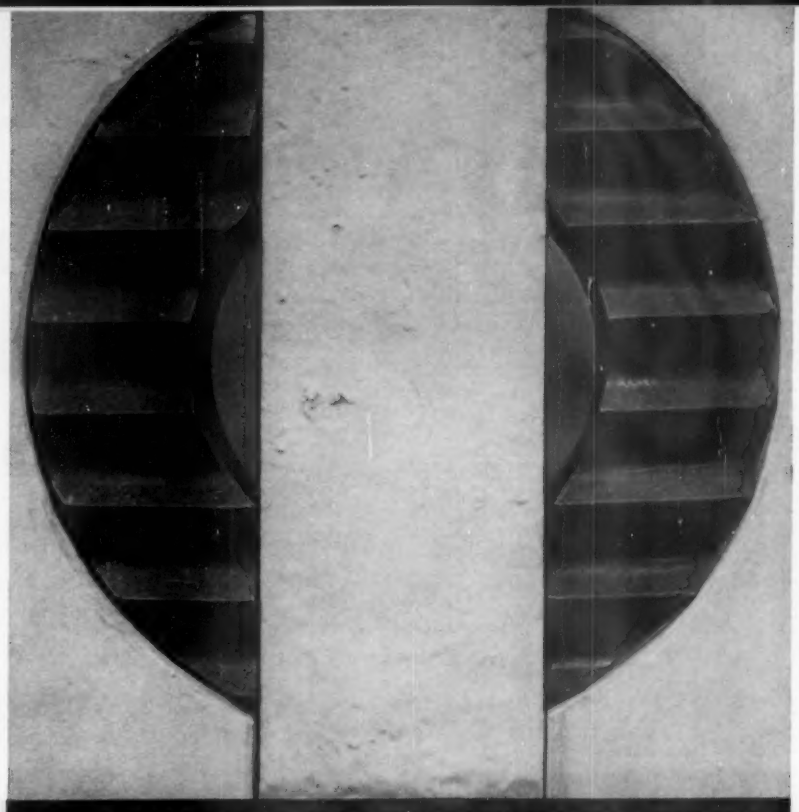
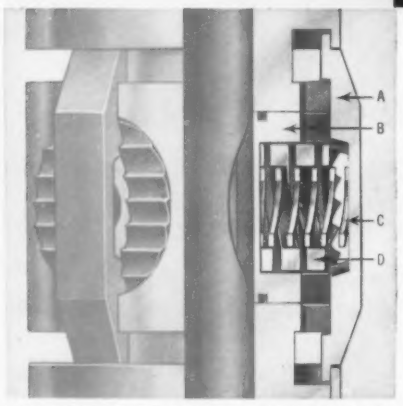
NEW!*

Product 418-03



* This unique slip button and retainer block combination represents a significant breakthrough in hydraulic tubing hold-down design.



THE SECRET OF SUPER-SPRING POWER

To prevent button dulling, retaining springs must be strong enough to resist pressure surges—yet they must not interfere with the operation of the hold-down. To get optimum spring performance, Baker developed a whole new design concept.

Look at the size of those corrosion-resistant springs shown above. Notice also that the Spring Retaining Block (A) is free to move inward or outward. The springs are placed *between* this movable bar and the Button (B). No matter what the inside diameter of the casing, effective spring travel remains the same. Thus the force required to push the buttons against the casing is always constant. Notice further that the smaller Inner Spring (C) forces the Blocks against the casing, but the large Outer Spring (D) undergoes no compression until it contacts the inner surface of the Retaining Block, as the button moves outward. This makes possible the use of a short, super-strength spring—one with sufficient inward thrust to resist pressure surges of over 100 psi, yet does not interfere with setting the hold-down in any weight of casing.

BAKER MODEL "K" TUBING HOLD-DOWN

VIRTUALLY ELIMINATES BUTTON DULLING

HOLDS ANY PRESSURE SAFE FOR THE CASING

OFFERS POSITIVE BUTTON RETRACTION

Here is the first hydraulically-operated tubing hold-down specifically designed to eliminate button dulling. Button dulling is the prime cause of hold-down failure, yet some hold-downs make no provision to keep slips retracted when pressure surges are encountered while running in. Others resort to ineffective leaf springs or snap rings.

Installed immediately above a hook wall packer, the Model "K" Hold-Down will prevent upward movement of the tubing and packer when pressure differentials are created below. Its extra-large buttons (three in the 5½", and four in the 7" size) provide more than ample holding power to withstand any pressure differential safe for the casing. The movable retaining blocks effectively center the hold-down and assure uniform loading of the buttons. Super-spring power (see left) assures positive button retraction, allows you to use this remarkable new hold-down repeatedly with minimum maintenance.

Ask your Baker man to explain more fully the unique engineering design that enables the Model "K" Hold-Down to outperform all others.

BAKER OIL TOOLS, INC. HOUSTON | LOS ANGELES | NEW YORK

BAKER

MODEL "K" TUBING HOLD-DOWN FOR USE WITH SET-DOWN HOOK WALL PACKERS

by D. M. Ellington

Frac Plan Pays Off In Gas Storage

A well-planned program of fracture treatments on 34 wells of New York's huge Dundee gas storage field has resulted in a 28.4% increase in peak day deliverability from these wells. At the same time, an increase in flowing pressure has reduced horsepower requirements at the compressor station.

The Pittsburgh Group Companies of the Columbia Gas System, owners of the big storage field, were faced with the problem of increasing peak day deliverability to serve their expanding market in the tri-city area of Binghamton, Johnson City and Endicott, N. Y. The problem could have been solved by drilling 42 new unfractured wells. However, drilling and fracturing 34 new wells resulted in the desired deliverabilities at appreciable savings.

Field Development

The Dundee gas storage field grew out of the old Wayne-Dundee field in the Finger Lakes region of New York. The discovery well, drilled in 1930, was completed in the Oriskany sandstone. By the summer of 1940, the field had produced a total recorded volume of 9,200,000 Mcf. The Dundee sector was then converted to a storage field and most of the wells in the Wayne sector were plugged.

The field is a domal structure approximately 6½ miles long and 1½ miles wide, with no evidence of faulting. It has a vertical closure of 80 ft, an average sand thickness of 15 ft, a net pay zone thickness of 8 ft and an average depth of 1800 ft. Producing limits in the field include approximately 4000 acres and are well defined by an edge-water closure.

By the end of 1940, 366,000 Mcf of gas had been stored in the relatively new field. At the end of 1950, this figure had risen to 3,447,000 Mcf. Storage at the end of 1960 had reached 9,043,000 Mcf. An ultimate storage capacity of 10,500,000 Mcf at the original field pressure of 765 psi is scheduled to be realized by the fall of 1963.

The cushion gas volume, or gas required to remain in the reservoir to create pressure energy for withdrawal purposes, is 6,000,000 Mcf. Turnover gas, or gas to be withdrawn and recycled annually, is 4,500,000 Mcf. Present peak day design deliverability of 52,000 Mcf is predicted to occur on Mar. 15, 1962. Pressure conditions that will exist to permit this delivery will be a back pressure of 300 psig and a shutin field pressure of 445 psi. There will be 110 wells on the line at this time.

The compressor station, located in the Dundee end of the field, has a total of 2280 hp. As a result of the favorable response of the wells to fracturing, it was possible to convert the compressor station to single-stage operation in late 1959.

Well Completions

Of the 154 wells known to be drilled in the Wayne-Dundee field, it presently is planned to utilize 115 for injection and withdrawal and

24 for observation. The remaining wells have been plugged because of poor spacing resulting from past town-lot drilling practices.

Two strings of casing and approximately 100 ft of drive pipe are required to reach the storage formation. The surface string is 8⅝-in. casing, set to shut off water and caving conditions at approximately 350 ft. The 5½-in. casing for the delivery string is usually set on top of the Oriskany sand, but is sometimes set through the formation. The drive pipe is necessary to get below the gravel of the glacial drift covering the area. All casing strings are cemented to the surface.

Wellhead equipment includes tee, top valve for cleanout operations, and side production valve. All valves are full-opening to minimize formation of hydrates.

The gathering system consists of 16, 12, 8, 6 and 4½-in. lines all coated, wrapped and cathodically protected.

Fracturing Program

Fracture treatment results are shown in Table 1. Comparisons are based on open-flow potentials before and after the fracture treatments. An impressive average increase of 12.4

Simple wellhead hookup is used for wells which are used for gas injection during the summer months and for production during the winter months.

times was realized, with the increase ranging from 3 to 51.2 times initial open flow. Three of the 34 wells treated are not included in these averages since the data are known to be invalid.

Table 2 illustrates the performance of the Dundee field before and after the wells were fractured and the Wayne sector was activated. Note especially that the volumes in storage are essentially constant and that the increase in delivery rate as of March 1960 was also at a higher flowing pressure along with an increase in the number of wells on line.

The backpressure method was employed to permit a comparison of the performance data shown in Table 2. This method permits a comparison of the deliverabilities under controlled conditions; that is, the effects of varying flow pressures, field pressures, number of wells on line, etc. are eliminated so that the deliverability rates per well before and after fracturing may be compared. By comparing deliverabilities per well for pressure design conditions for a peak day send-out, the usable results of fracturing become evident. This comparison is shown in Table 3.

The 28.4% increase in deliverability realized from the fracturing program can be vividly expressed in terms of wells: drilling and frac-

Table 1. Fracture Results

Well Number	Initial Flow Rate Mcf	Final Flow Rate Mcf	Times Increase
H-58	386	10,280	26.5
H-70	1280	11,110	8.7
H-106	590	3,720	6.3
H-121	1100	22,500	20.4
H-128	518	6,150	11.8
H-137	1220	25,330	20.8
H-139	771	8,610	11.3
H-140	1240	6,240	5.0
H-142	79	12,500	158.0*
H-143	120	6,150	51.2
H-144	244	3,340	13.7
H-145	423	6,240	14.7
H-146	399	4,750	11.9
H-148	173	2,970	17.2
H-153	1110	9,390	8.4
H-155	1500	16,180	10.8
H-162	874	2,970	3.4
H-168	153	2,590	16.9
H-172	346	10,280	29.7
H-174	1610	5,740	3.6
H-180	411	5,940	14.4
H-182	1380	5,430	3.9
H-183	1108	11,870	10.7
H-184	360	5,430	15.1
H-185	1176	5,740	4.9
H-186	3090	3,720	1.2*
H-187	1180	3,600	3.0
H-188	259	2,110	8.2
H-190	8	1,870	234.0*
H-191	2630	12,600	4.8
H-194	1180	3,720	3.2
H-195	823	7,500	9.1
H-193	1110	9,520	8.6
H-196	2520	13,930	5.5

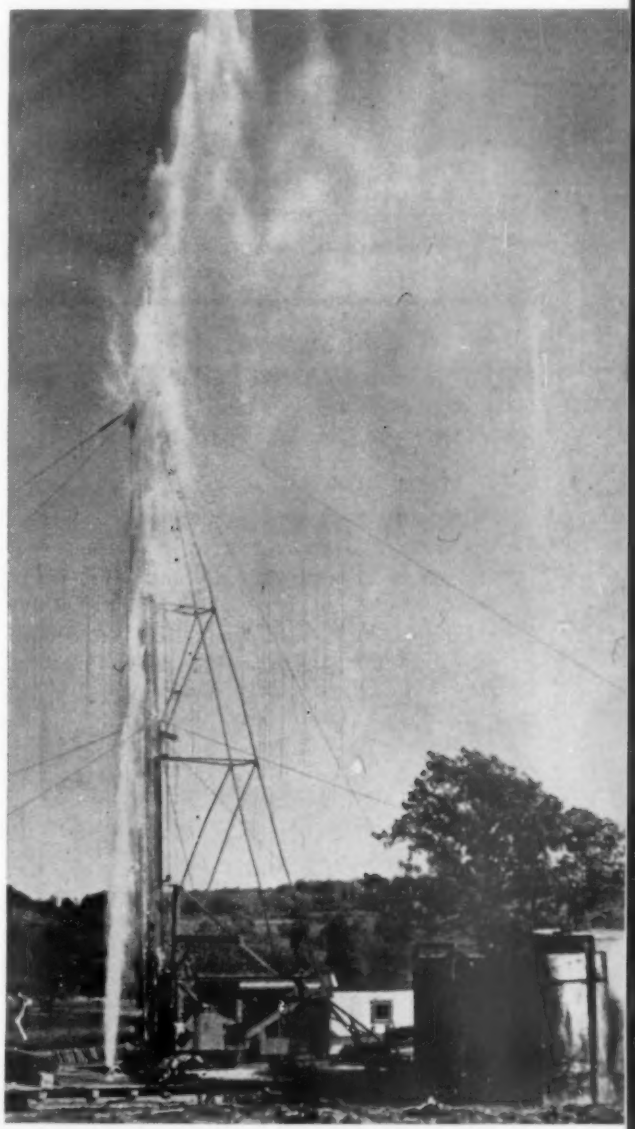
* Data invalid.

Table 2. Actual Performance Data.

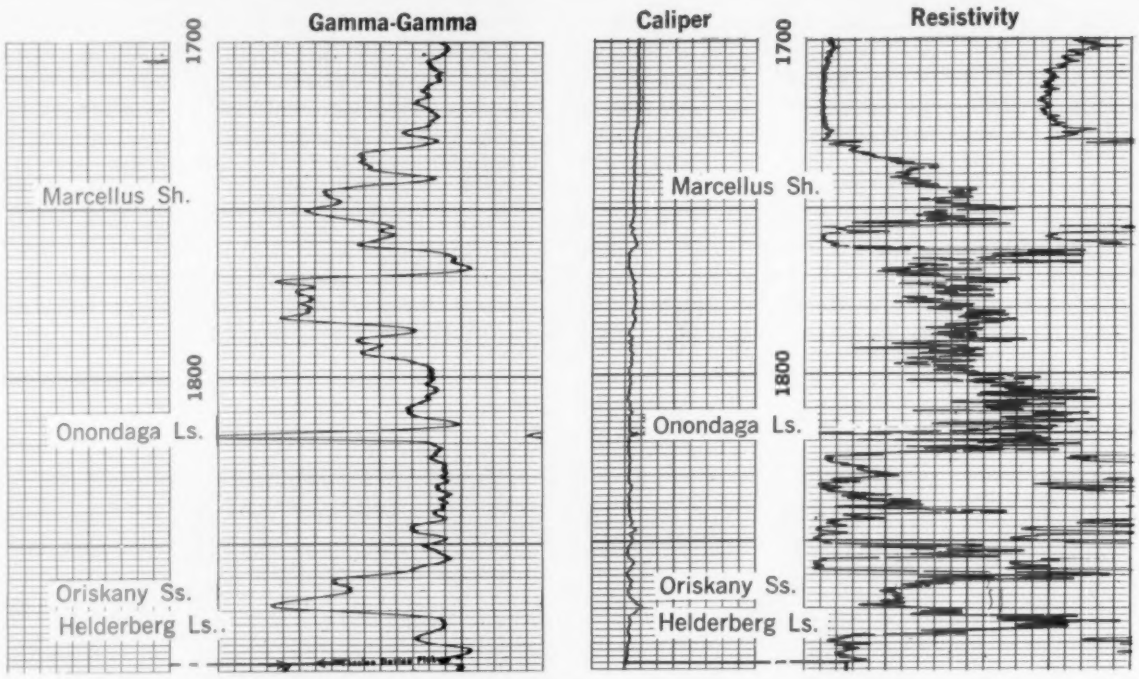
Date:	March 1957	February 1958	March 1960
Wells on line:	45 Dundee 45 total	16 Wayne Sector 1 fractured 61 total	50 Wayne Sector 34 fractured 95 total
Volume in storage:	6,440,370 Mcf	6,454,251 Mcf	6,476,939 Mcf
Field pressure:	455 psig	455 psig	415 psig
Flowing pressure:	176 psig	151 psig	243 psig
Delivery:	29,164 Mcf	36,092 Mcf	44,132 Mcf

Table 3. Design Conditions for Peak Day Deliverability.

Field pressure:	470 psig
Flowing pressure:	300 psig
Deliverability/well before fracturing:	475 Mcf
Deliverability/well after fracturing:	610 Mcf
Net Increase/well:	135 Mcf
Percent increase from fracturing:	28.4%



Wells are blown to the atmosphere after the fracture treatment to unload the processing fluid. Wells are also blown periodically to clean the sand face.



Extensive logs were run to analyze fully the formations used for gas storage. These four logs are typical

turing 78 wells would be equivalent to drilling 100 untreated wells. This would mean that 22% fewer wells would be required to maintain the desired deliverabilities. Eliminating the necessity of drilling these wells reduced substantially the potential investment, operation and maintenance costs and will provide a much lower cost of service for the Dundee field.

Fracturing the wells also has a definite effect on storage turnover by lowering the cushion gas requirement for peak day deliveries, thereby making cushion gas available for current delivery. This means that with a higher turnover or usage factor for a given field, savings may be realized by postponing or possibly eliminating construction of new storage areas.

The fracturing treatment found to be most successful for the Dundee field is:

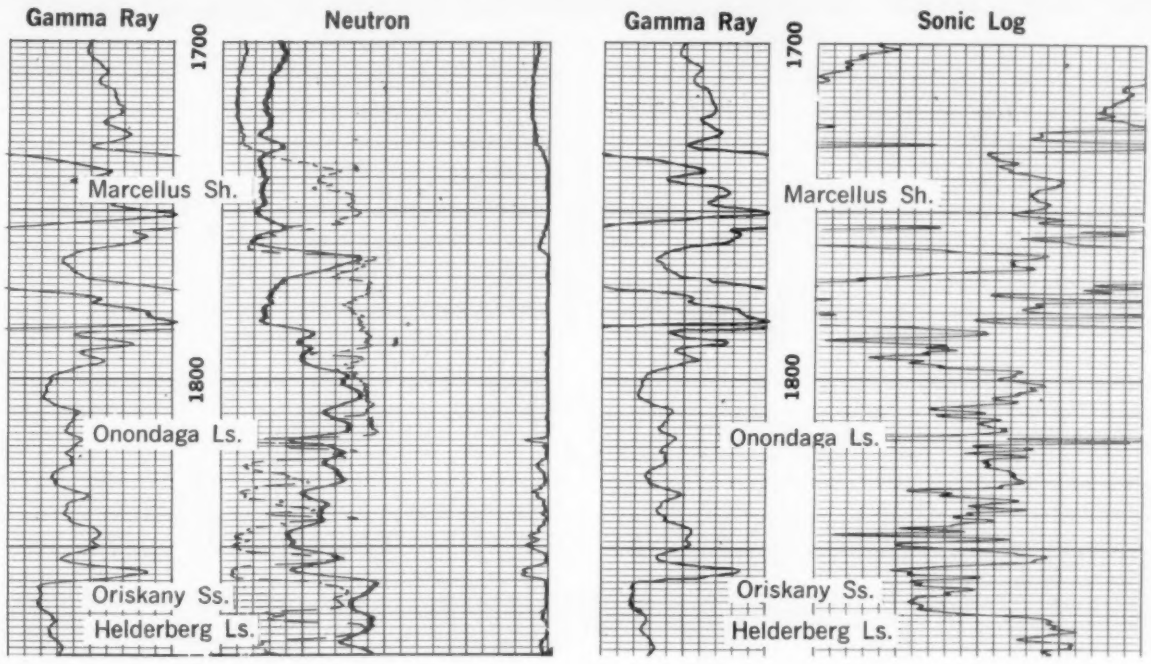
1. Mud cleanout acid: 250 gal.
2. Water and surfactant: 2000 gal.
3. Gelled water: 10,000 gal.
4. Sand (20-40 mesh): 10,000 lb.
5. Injection rate: 35-40 bbl/min.
6. Breakdown pressure: 1800-2200 psig.
7. Treatment pressure: 1700-2200 psig.

During early fracturing attempts in the Dundee field, it was discovered that unloading the wells immediately after fracturing returned a greater percentage of the total processing fluid from the reservoir and that very little sand was returned. This made it much easier and less costly to clean up the wells and to turn them back into the line. This procedure has been followed for all the wells fractured in the field.

Variations Tried

Many variations of the fracturing treatment were tested in an attempt to improve the results. Some of the variations included:

1. Varying sand size for the total treatment or for tailing-out operations only, as well as complete elimination of propping agent.
2. Variation of sand concentration.
3. Use of mild acid in addition to gelled water.
4. Variation of injection rates.
5. Open-hole and set-through well completions.
6. Variation of treatment volume.



and all were run in the same well, Home Gas Company's Miles Houck H-190, in Schuyler County, N. Y.

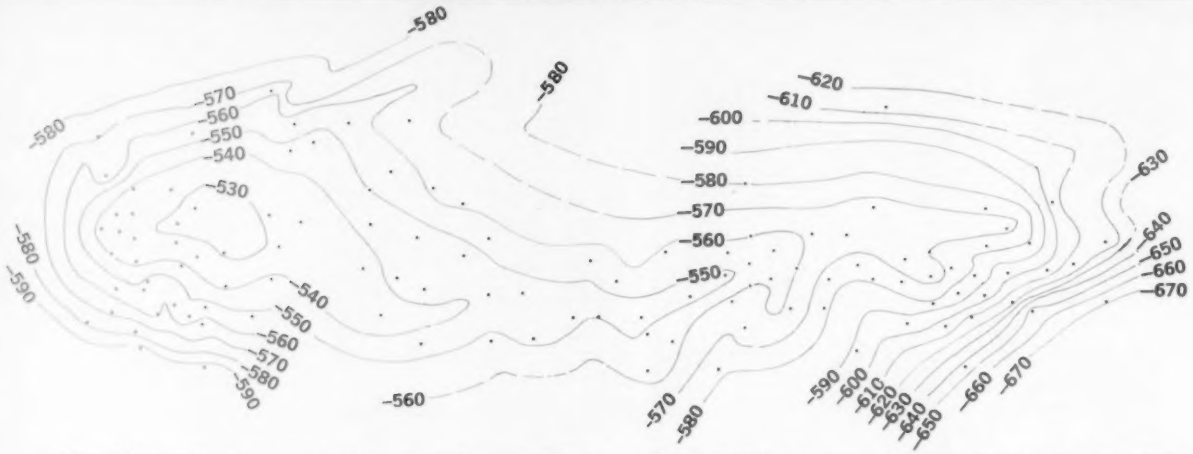
Prior to any variation in treatment, a sufficient number of wells had been fractured satisfactorily to establish definitely a pattern or trend to be used as a basis for comparison. By using this approach each time a variation was made, it was possible to evaluate the results with a fair degree of certainty. Approximately 20 wells had been successfully fractured before any variation in treatment was attempted.

The first area of experimentation was that of injection rate. An injection rate of 30 bbl/min had been used successfully and it was decided to lower this rate to 10-15 bbl/min. This treatment resulted in a very low increase in open flow rate, averaging 1.2 times the initial open flow rate. Increasing the injection rate to 40 bbl/min had no significant effect on the results.

Next, variations were made in the size of treatment. The 10,000-gal water and 10,000-lb sand volumes were increased to 20,000-gal water and 20,000-lb sand treatments. Normal pressures and rates were required for this larger treatment, yet no significant difference in outcome was observed.

Various sand concentrations ranging from ½ to 3½ lb/gal were tested with no apparent

Cores from the Oriskany sandstone showed a naturally-occurring vertical fracture.



The Wayne-Dundee gas storage field, containing some 4000 acres and defined by an edge-water closure, is used by the Pittsburgh Group Companies of Columbia Gas System to provide a 60,000-Mcf peak day deliverability to local markets. Fracturing 34 of the wells resulted in a 28.4% boost of peak day deliverability from these wells. Contours mark sub-sea depths of Oriskany sandstone.

effect on the results. Different sand sizes also were used with no significant effect.

One well was fractured without any propping agent used. There was a definite increase in open flow rate, but not up to the estimated pattern. When the well was blown several months later, the open flow rate had materially diminished. This was a very significant development since other wells, when blown as much as two years after treatment, not only had maintained the increased open flow rate but had increased somewhat, definitely establishing the fact that the fractures propped open with sand have permanently increased the productivity of the well.

The type of completion had no effect on the fracturing results. Wells with casing or tubing set through the formation required from 500 to 800 psig more pressure to break down the formation than did the wells with open-hole completions. However, pressures required for the main treatment were essentially the same.

A core was taken to determine if some improvement could be made in the fracturing program. The standard core analyses for porosity and permeability were made along with fluid-compatibility tests for possible swelling clays, acid solubility and fluid loss. Maximum porosity was 8% and average was 2.7%. Maximum permeability was 50 millidarcies and average was 8.3 md. Solubility to hydrochloric acid ranged from 0 to 14%, and no clays were present to create swelling problems.

The core did show a naturally-occurring vertical fracture throughout the bottom 3 ft along with several interesting fossils. This information led to speculation that the fractures are vertical throughout the field. This would also explain the apparent indifference the formation exhibits for the type of well completion.

A 5%-acid fracture treatment was performed on three wells after the core analysis showed a favorable solubility to HCl. Results for the three wells were substantially below average and the acid-fracture treatment has not been attempted since. As yet, no reasonable explanation has been developed for this apparently peculiar behavior.

The Dundee field can be considered completely successful. It can deliver 60,000 Mcf on the peak day and its annual turnover of gas is 4,500,000 Mcf. Much of its success is due to the outstanding results of the fracturing program. Without a doubt, more wells, more lines and more compressor horsepower with an attendant increase in cost of service would have been required if fracturing had not been of such benefit.

About the Author

D. M. Ellington is chief storage engineer in the production and storage department of the Pittsburgh Group Companies, Columbia Gas System. He received a BS degree in Petroleum Engineering in 1952 from the University of Pittsburgh and has been with the Pittsburgh Group Companies since that time. He is a member of the Pennsylvania Natural Gasmens Association, American Petroleum Institute and is present chairman of the petroleum sub-section of the AIME.

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by Wallace B. Johnson

Don't Overlook Permeability Profiles

Production or injection profiles are emerging dramatically as diagnostic tools in workover and remedial planning. Recent developments permit you to obtain them with minimum effort and nominal expense and, even in the more expensive cases, you get valuable information that completely overshadows the cost.

Increasing activity in waterflood projects has helped stimulate interest in profiles, and, as a result the value of profiles in production well performance is being made more apparent every day.

How to Obtain Profiles

You can use two basic methods to obtain permeability profiles: (1) radioactive isotopes and (2) mechanical.

There are two commonly used radioactive isotope surveys. One is a survey whereby radioactive isotopes are discharged into the well stream and timed over a measured interval. This is a velocity type survey based on fluid travel rate. A special gamma tool is used. This survey can be run through tubing.

The second radioactive survey disperses isotopes into one of two injection streams. Fluid injection rates are proportioned between tubing and casing by control of pressure and rate. The two fluid columns are manipulated in such a way that an interface is established and determined by radiation intensity. Injection quantities are then calculated from these data. This survey uses a small ($1\frac{1}{16}$ or $1\frac{3}{4}$-in. OD) gamma tool which is operated inside the tubing string.

There are also two mechanical methods in use today. The first is a conventional spinner run in the casing or open hole only. Tubing must be out of the hole. This survey measures injection or produced quantities by spinner rate and use of a calibration curve based upon fluid velocities.

The second mechanical survey is a through-tubing tool using an impeller and an inflatable packer. This small tool ($1\frac{11}{16}$-in. OD) measures injected or produced volumes quantitatively by forcing all fluid through the impeller section. The packer is of such a design that multiple settings can be made in casing or open hole on the same run. Also, direction of fluid movement can be determined from the known direction of spinner rotation.

When to Run Profile

Often in waterflood operations, the question is asked, "When should I run an injection profile?" The exact time depends upon a number of factors: type of reservoir, original well completion, production performance during primary recovery, previous well treatments and workovers.

This information and its importance varies with each flood project. In some fields, previous production experience has indicated thief zones, gas sands of high permeability or other undesirable sections. These wells should be sur-

veyed prior to conversion to injection wells so that the workover can be properly planned, then surveyed after workover to check the job. In fields where it is definitely known that no undesirable downhole conditions exist, the profile might be delayed until a steady or smooth injection rate is established.

When you consider the money invested in the flood project, then time becomes important because time means interest. For example, say that the project investment totals $700,000 and yearly operating costs are $43,800 ($120 per day) averaged throughout the life of the flood. Also, suppose that calculations indicate a payout in the third year of operation. Should the injection water not go into the zone to be flooded and the project be delayed three years, then earnings have been lost. Interest on the money tied up for the additional three years would amount to $142,084 at 6% or $301,184 at 12%.

Injection profiles could have been obtained for a total cost of from $10,000 to $15,000. Profiles obtained in the initial phase of injection would have warned the operator that the flood was not going to perform in the most efficient manner.

While these figures are impressive, they do not take into consideration the extra maintenance, repairs and replacements of equipment nor changes in labor rates or crude prices. But, they certainly are indicative of the order of magnitude of the risk taken when water is put underground "helter-skelter."

Fig. 1 illustrates a profile that was run to check injection. The profile showed the water to be going into the oil sand. Only 5% of the injected water was going into the zone from the liner seat to a point 16 ft below. In this well, a liner had been cemented through a section known to be a depleted gas sand of high permeability. Also, a water-bearing lime section exists a short distance below the sand to be flooded.

Fig. 2 is a profile obtained on an injection well after water breakthrough had occurred in the offset producing well. This well is completed in a dirty and tight lime with low porosity. The first profile showed water to be leaving the borehole just below the casing seat. The zone taking water was squeezed with cement. The hole was drilled and cleaned out to bottom and

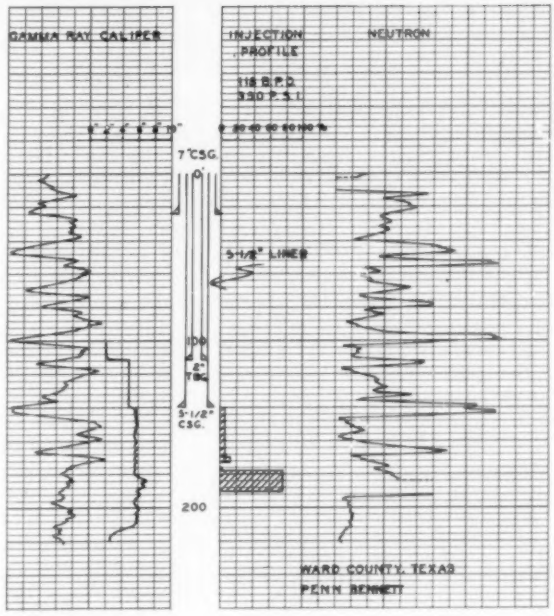
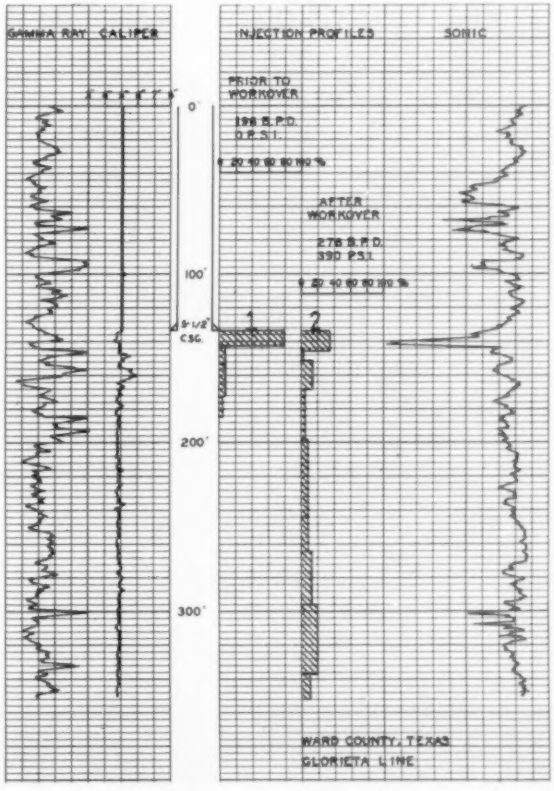


FIG. 1. Injection profile was run to determine point of entry and volume of water being injected in a West Texas waterflood project.

FIG. 2. Two profiles in an injection well show distribution of injection water before and after highly-permeable zone at top of section was worked over.



Well treatments receive special benefits from permeability profiles in West Texas-New Mexico area where most of the formations are thick limes with varying streaks of porosity and permeability.

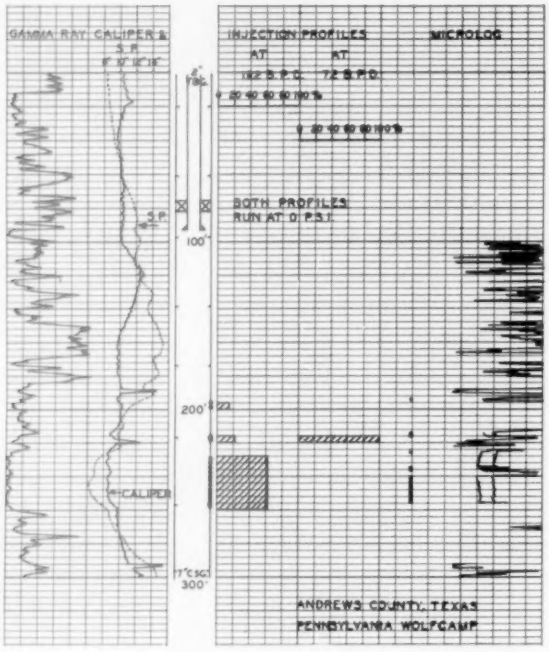


FIG. 3. Effect of injection rate is shown in these two profiles. At 72 bpd, all water was entering the middle set of perforations. At 192 bpd, all perforations took water.

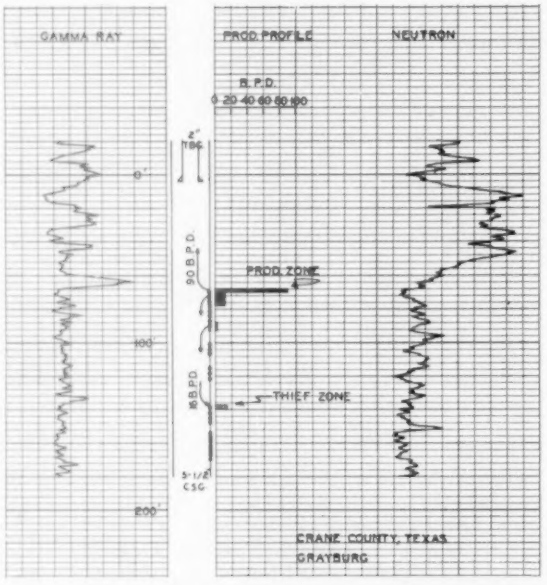


FIG. 4. A thief zone which was taking 15% of this well's total production was discovered in a production profile. Proper workover corrected this loss of production.

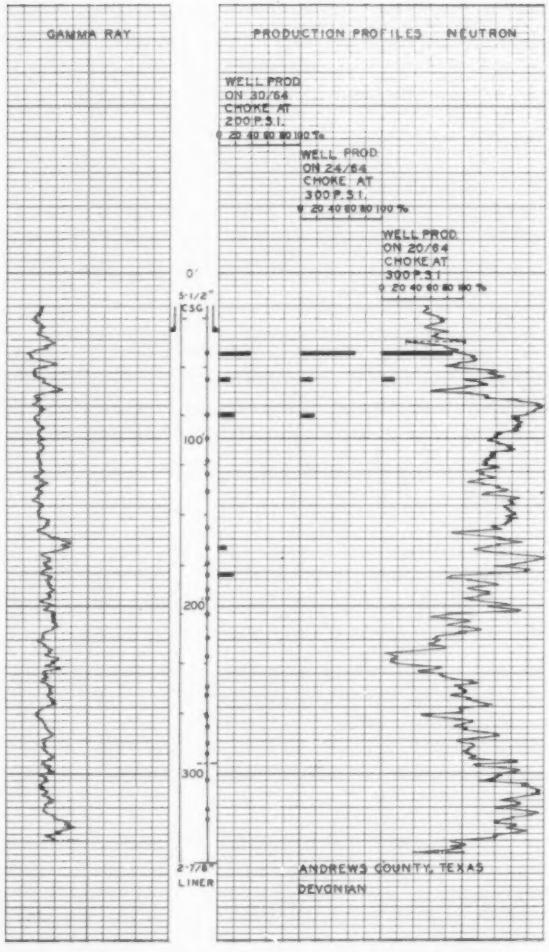


FIG. 5. Source of production at three different producing rates was determined from three profiles. Productive zones dropped from 5 to 3 when choke was reduced from 30/64 to 20/64-in.

was not treated. Water injection was resumed and a second profile run to check injection. The second profile (after remedial operations) indicated water injection throughout the formation.

These two profiles, even though run on an injection well, indicate that the first profile most likely represents the zone that produced most of the oil during primary life. During primary, the well was acidized and several years later fracture treated. The fracture treatment was down the casing at 1300 psi and 19 bpm. Water injection after workover is at a lower pressure and rate. Hence, it appears that both treatments entered the zone as shown in Fig. 2 (first profile). This illustrates the need of a profile to design and evaluate well treatments. In this case, selective well treatment could have enabled the lower zone to produce and make better use of original reservoir energy.

The next well shown was to be an injection well and the operator wanted to know what effect different injection rates would have. Fig. 3 shows the profile at an injection rate of 72 bpd. At this rate and zero wellhead pressure, all the fluid was going into the middle set of perforations. The injection rate was increased to 192 BPD (zero pressure) and the profile changed as shown. At this rate, all three zones were taking fluid in a distribution approximating the perforation density.

Fig. 4 is a producing well that started making large quantities of water. A production profile was run which showed fluid entry at the top perforations. Fluid was flowing to the surface at 90 bpd. Also, from the same point, fluid was moving downhole at 16 bpd and into a lower set of perforations. This phenomenon has been detected in numerous production and injection wells in West Texas.

Fig. 5 shows a Devonian producing well. This is a hard lime, gas-solution type reservoir found throughout the West Texas-New Mexico area. In this case, the operator was interested in evaluation of a fracture job and what effect different producing rates would have. The profile was run while the well was producing on a 30/64-in. choke. At this rate, five zones were found to be producing. The choke was reduced to 24/64-in. and the profile showed that only the top three zones were then producing. The third choke size, 20/64-in. changed the profile again. At this rate, only the two top perforations were producing. These profiles indicate that the various zones produce at different draw-downs and that about 100 psi difference in pressure is causing this.

The five wells discussed illustrate some of the uses of a permeability profile:
In secondary recovery —

1. To determine if thief zones and non-productive zones are properly isolated.
2. To determine if injection fluids are entering various zones as desired.
3. To make sweep efficiency and breakthrough calculations.
4. To determine if corrosion products are plugging main zones or altering downhole injection patterns.

In workover and remedial —

1. To determine location for packer seats to isolate water or gas.
2. To locate proper point for plug-back with cement.
3. To determine need for selective acid or fracture job.
4. To design selective well treatment.

A great amount of money is spent in acid and fracture work in the West Texas-New Mexico area. Most of the formations are thick limes with varying streaks of porosity and permeability. Also, they are broken up with shale and sand stringers. These conditions require selective zone treatments to obtain the desired results. When one considers that such treatments range from $4000 to $16,000 in total cost to the operator a permeability profile can be valuable in planning such jobs. There is growing evidence that many well treatments do not give desired results because the treatment goes into some unsuspected non-productive or thief zone. Proper use of profiles in well treatment will result in a higher success ratio and reduced treatment and completion costs.

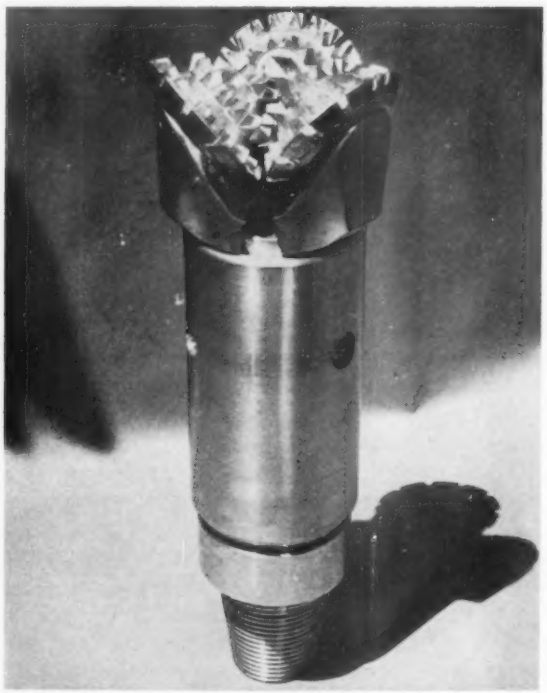
About the Author

Wallace B. Johnson is sales manager for Wright Surveys Inc., a specialized logging service. Formerly, he was district production engineer and then senior operations engineer for The Atlantic Refining Co. in Odessa and Midland, Tex. His Atlantic assignments involved numerous and varied secondary recovery projects. Johnson holds a BS degree in Mechanical Engineering from Southern Methodist University and, for several years, has been a member of the administrative committee of the West Texas Oil Lifting Short Course sponsored by Texas Technological College. He is a member of the Society of Petroleum Engineers of AIME and Registered Professional Engineer in Texas.

■

Component parts of new rock bit design. One shank section with cutter cone has been set in position inside the sleeve to show how the circular wedge functions.

Circular wedge resting on top of adapter sub in the same relative position when these two parts are made up inside the sleeve at left.



Assembled replaceable cutter cone type rock bit shows close resemblance to conventional triple cone rock bit. Holes in sleeve position each shank section.

New Bit Uses Replaceable Cutter Cones

You can put together your own two — or three — cone rock bit in the field and, after use, take it apart to replace worn cutter cones. Making possible this unconventional operation is an unusual drilling bit design first introduced by Varel Manufacturing Co. of Dallas, Tex., about 1½ years ago.

Primary application, then and now is for drilling seismic shot holes and blast holes in mines and quarries.

It has evolved, through modifications of the basic design, to include 4¼, 4½, 4¾, 6 and 6¼-in. OD rock bit sizes.

Basic construction of cutter cones and shank sections is very much like that used in conventional oil well rotating cutter cone rock bits. The new bit resembles the conventional triple cone rock bit but has a longer body. And, it functions in the same way. Its primary difference is a design that permits assembly or disassembly in the field.

Basic parts are: (1) adapter sub; (2) sleeve or collar; (3) circular wedge or spacer wedge; and (4) shank sections with cutter cones.

The shank section that includes a cutter cone looks very much like the conventional rock bit cutter cone. It has ball and roller bearings and a bushing sleeve-type bearing. Taper and size of the shank is varied according to bit size. However, the same size shank is used on a two or three-coned bit for any given size bit OD. A double taper is milled on the shank as the first machining operation. Subsequent machining is oriented to this first double taper to make a precise and positive alignment when the bit is assembled. Forged buttons on the outside of the tapered shank serve to orient or position each of these sections inside the sleeve or collar.

The circular wedge has 90-deg vee-cuts at an incline to its longitudinal axis. A three-cone bit would have three cuts in the wedge while a two-cone bit would only have two. Holes in the wedge segments of the circular wedge make it possible to employ jets for use with air, gas or liquids as the drilling medium. Interchangeable jet nozzles may be used in the center hole in this circular wedge for added jetting action.

A special heat-treated alloy steel sleeve serves as the body of the bit and holds the parts together. Inside the upper end (in relation to the bit's drilling position) of this sleeve are heavy-duty, square-shouldered, non-tapered threads. These threads accept the adapter sub which forces the circular wedge between the shank sections.

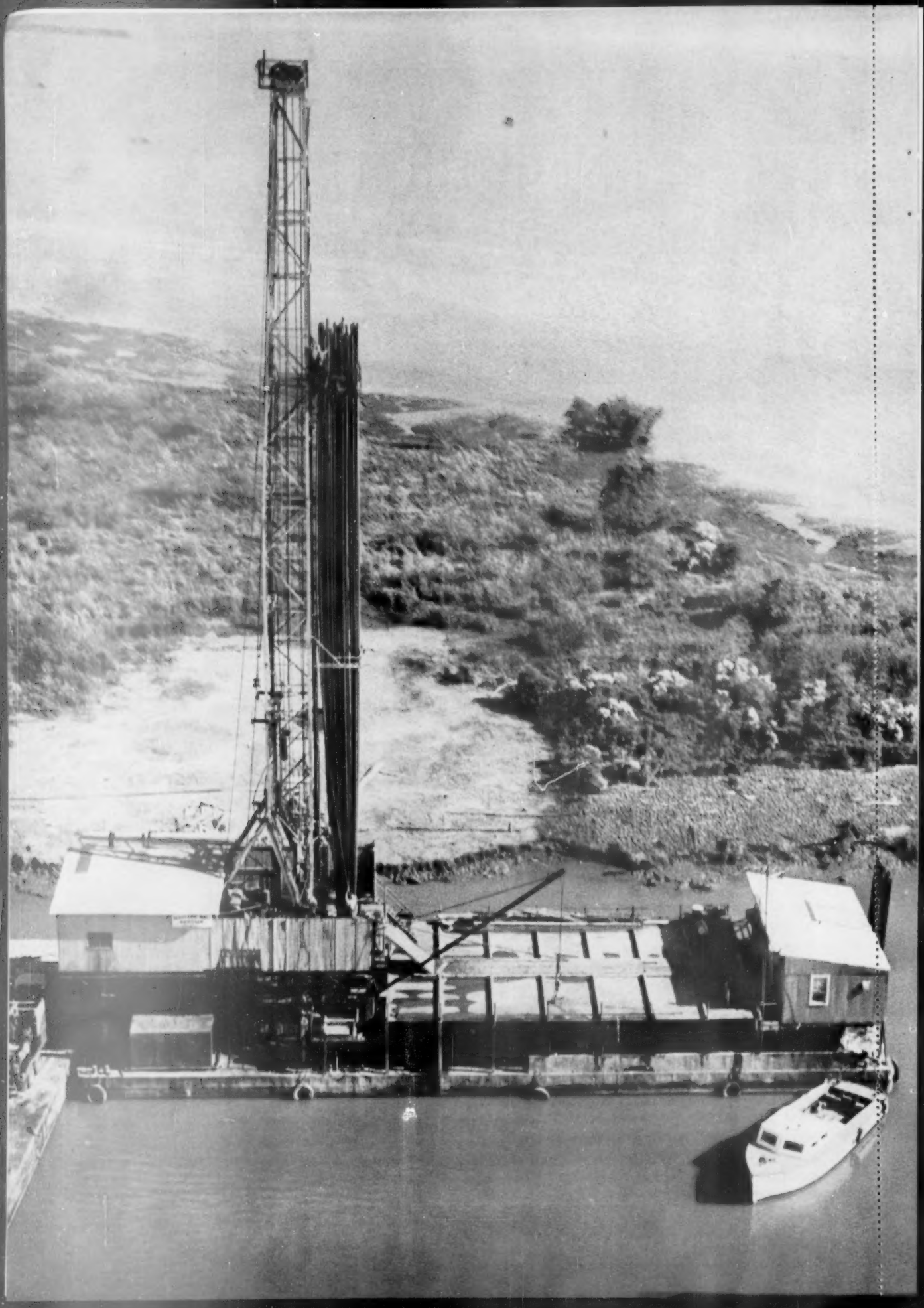
To assemble such a bit, the circular wedge is first placed inside the sleeve or collar. Since its outside diameter is greater than the inside diameter of the square-shouldered threads of the sleeve, the circular wedge must be inserted in the opposite end. The shank sections . . . two or three, as the case may be . . . are set inside the sleeve so the buttons on each shank fit in the holes in the sleeve. When all shank sections are in place, the bit is turned over so it rests on the cutter teeth, to allow the circular wedge to drop down between the shank sections. The adapter then is screwed into the sleeve and made up tight.

Disassembly is just as simple, for the adapter sub is broken out easily from the sleeve because of square shouldered threads. Worn cutter cones can be replaced on the rig floor with new shank sections without discarding the other parts.

Designer of the replaceable bit, Charles Bronson, chief engineer for Varel, relates that experience to date in mining and quarry operations indicates that this unique bit design has resulted in longer bearing life. Reason for this, he reports, is the assembly's inherent flexibility that dampens shock loads.

Bit weights of 35,000 lb on the 6¼-in. bit are not uncommon.

This new type replaceable two or three-cone rock bit has been tested in deeper holes for oil and gas well drilling. The basic design idea, however, lends itself to larger diameter sizes because it permits an increase in the number of standard shank sections to make a multi-cutter rock bit. ■



by Lowell A. Murphy

Special Rig Tackles Deep Workovers

IF necessity is the mother of invention, then credit the South Louisiana oil fields with giving birth to a most unusual well servicing and workover rig. You can see towering over this region what at first glance looks like a big submersible drilling rig but what in reality is a deep-well servicing and workover barge rig capable of working to 17,000 ft with 2⅞-in. drill pipe.

This rig is owned by Mallard Well Service, Lafayette, one organization that has risen to meet South Louisiana's special demands on oil men and equipment.

Started in 1952 by E. F. "Gene" Fullen with two rigs and nine employees, the company has grown to its present size of four land rigs, one barge rig and 49 employees. While this growth is certainly an indication of the company's success, perhaps a more significant indication is the fact that all of the company's men and equipment have been operating for some time at near 100% availability.

What does it take to service and work over wells successfully below 10,000 ft? In a nutshell, it requires competent personnel operating sound equipment specially designed to do the job. While this simply-stated formula is, of course, the foundation of success in any operation, perhaps it is best typified in Mallard's Barge Rig 3.

At first glance, the big Barge Rig 3 looks like one of many submersible drilling rigs operating in the inland waters of the Gulf Coast. A 126-ft cantilever derrick with a 420,000-lb capacity towers over the double-drum drawworks powered by two sets of twin diesel engines (600 hp). The spacious rig floor is 15 ft above the uncluttered barge deck, providing plenty of room for the 6-in. Series 1500 annular blowout preventer and the combination ram-type blowout preventer and fluid operated master valve.

But in spite of its similarity to a big drilling rig, this unit was conceived and constructed for the exclusive job of deep-well servicing and workovers and is kept busy doing that job. The rig rarely works at depths shallower than 10,000 ft. It works at a rate competitive with smaller rigs designed specifically for more expensive drilling operations.

The welded steel barge measures 125 ft long, 36 ft wide, and 11 ft deep. A 10-ft wide slot extends 9½ ft inside the centerline of the derrick. The 7000-gal fuel tank is located at the end of the barge with a 25-kw generator powered by a 70-hp diesel engine and a utility unit consisting of a 6-cfm air compressor and a 25-kw generator, both driven by a single 106-hp diesel engine.

The main mud pump is a 7½-in. by 12-in. pump powered by a 305-hp diesel engine. Another pump, rated at 5000 psi maximum working pressure, is equipped with a torque converter and driven by a 200-hp diesel engine. A 6-in. centrifugal mud-mixing pump, a 2-in. centrifugal water pump, and an air compressor are all powered by a 200-hp diesel engine.

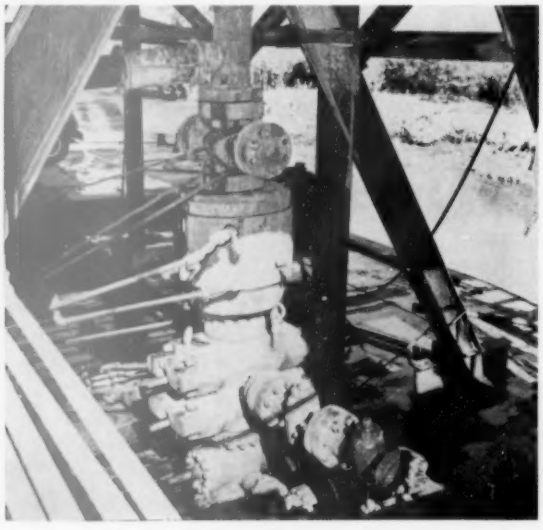
Two 28-ft by 7½-ft by 5½-ft mud tanks hold a total of 400 bbl of mud. The shale shaker

Rig 3, Mallard Well Service's big barge rig, operates in the inland waters of the Louisiana Gulf Coast. Measuring 125 ft by 36 ft, the barge is fully equipped to workover the area's deep wells to a depth of 17,000 ft with a 2⅞-in. drill pipe.

Double-drum drawworks powered by two sets of twin diesel engines (600 hp) form the heart of Rig 3. A 126-ft cantilever derrick with 420,000-lb capacity rises above the rig floor.

Mud system includes a 6-in. centrifugal mud-mixing pump and a 2-in. centrifugal water pump driven by the 200-hp engine at far right. Steel mud tanks hold a total of 400 bbl of mud.

High pressures encountered in the Gulf Coast area require substantial blowout preventer equipment. This stack consists of a 6-in. Series 1500 annular preventer and a fluid-operated combination ram-type preventer and master valve.



E. F. "Gene" Fullen (left), owner of Mallard Well Service, founded the company in 1952 with two rigs and now operates four land rigs and one barge rig. Gilbert Hebert (right) is toolpusher on Barge Rig 3 and has been with Mallard for three years.

is suspended below the rig floor to leave the barge deck clear and unobstructed.

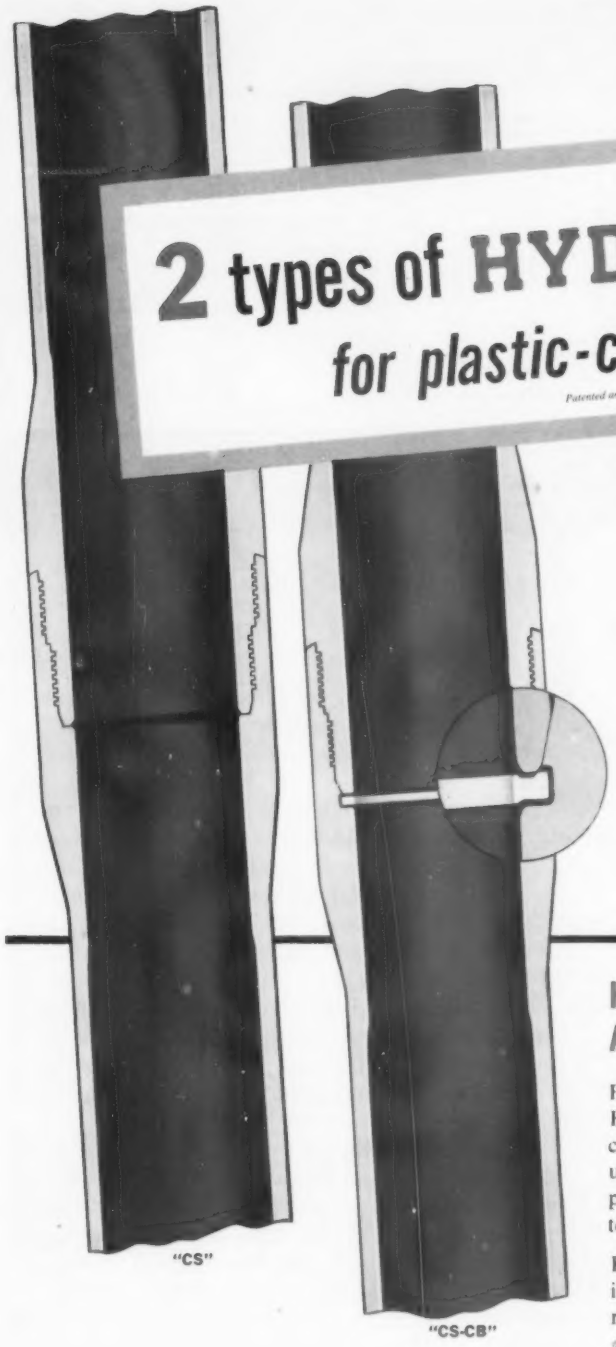
Air conditioned crews' quarters located on the end of the barge contain beds for six men, bath and electric kitchen.

Spotting the rig on a location is a precise operation. After the barge has been towed to the well by a tug, submerged jets of water are used to spot the barge over its exact location with the wellhead entering the slot. When the barge is spotted, ballast tanks are pumped full of water to sink the barge until it rests on bottom. Two heavy anchor columns at opposite corners of the barge are weighted into the bottom to prevent any lateral movement of the submerged barge. The rig is then ready to go to work.

Mallard's land rigs are led by Rig 4 which has a single-drum drawworks powered by a 260-hp natural gas or butane engine with torque converter. Its 96-ft steel mast-type derrick has a capacity of 250,000 lb and all equipment is mounted on a heavy-duty tandem trailer. The rig inventory also includes a 7¼-in. by 10-in.

2 types of HYDRIL "CS" joints for plastic-coated tubing!

Patented and Patents Pending



In corrosive wells . . . or to resist costly paraffin buildup . . . operators are turning more and more to plastic coating the I.D. of tubing. The joint is the critical spot in this operation: if coating flows over the *end* of the pin, it will hold off a tight-sealing makeup; if coating stops short of the end of the pin, the critical sealing point is left unprotected.

Standard Hydril "CS" Tubing Joints are the ideal answer where the problem is to retard paraffin buildup, to resist mild corrosion or to run in corrosion-inhibited wells. Coated to the 90° bore shoulder and made up power-tight, the "CS" joint seats metal-to-metal at all three seals, and the coating closes coat-to-coat to protect them.

HYDRIL "CS-CB"* JOINT ASSURES TOTAL PROTECTION

For extremely corrosive gas-condensate wells, the Hydril "CS-CB" Tubing Joint incorporates a resilient corrosion-resistant Teflon ring. When this joint is made up power-tight, the Teflon ring is compressed between the plastic-coated shoulders for total coverage . . . and total protection.

For details on Hydril joints for plastic-coated tubing, including proper coating techniques, see your Hydril representative, or write for Bulletin PCT-59.

**"CB" means Corrosion Barrier*

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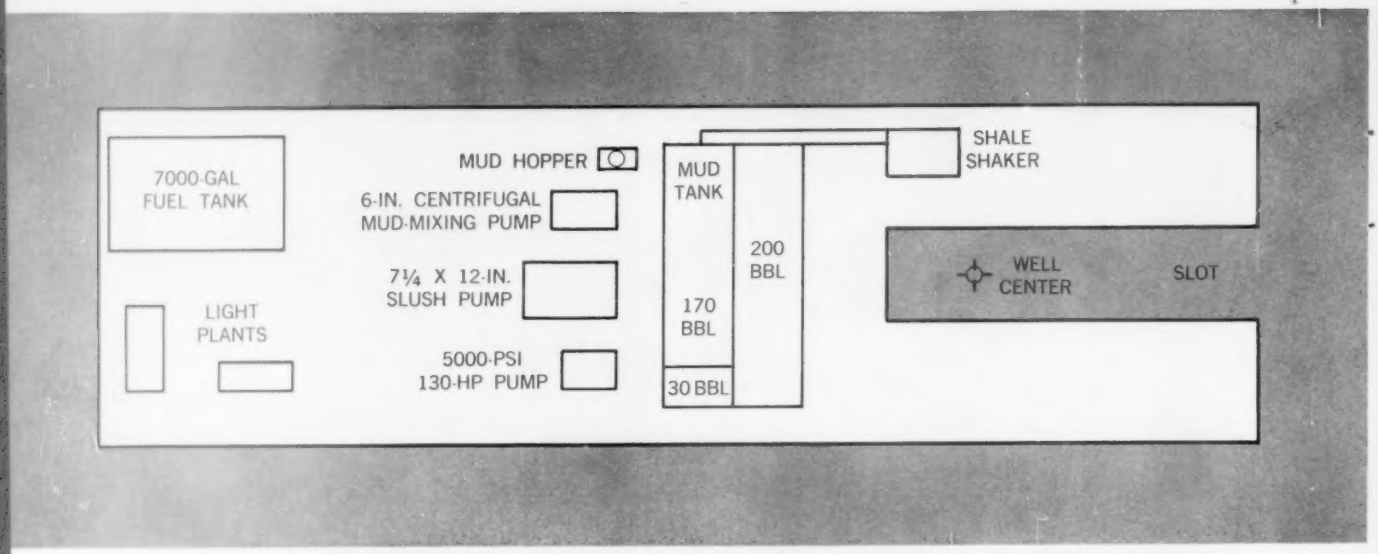


Plan of barge deck shows the major pieces of equipment on Barge Rig 3. The crews' living quarters are located above the fuel tank and light plants (left) and a 36-ft by 50-ft pipe rack extends to the rig floor.

slush pump powered by a 191-hp engine, a 5-in. by 10-in. slush pump driven by a 161-hp engine, and a 6-in. centrifugal mud-mixing pump powered by a 100-hp engine. A 4½-in. by 6-in. water pump is powered by a 25-hp engine. A 6-in. Series 1500, fluid operated combination blowout preventer and master valve is also provided.

Rigs 7 and 9 are almost identical, both having single-drum drawworks and a 65-ft, 150,000-lb steel mast-type derrick. The units carry 6-in. Series 600 to 900, manually-operated blowout preventers. A racking board permits standing pipe in the derrick in singles, and rods can be hung in a rack in doubles. Power tubing tongs, hand tools, slips, elevators, etc., are available for working with 2 or 2½-in. tubing and rods.

Rig 1 is a single-drum drawworks unit and has a 51-ft, 90,000-lb mast-type derrick. A 6-in. Series 600 to 900, manually-operated blowout preventer accompanies the rig. Power tongs and hand tools are provided for working with 2 and 2¼-in. tubing and rods.

While Mallard president, Gene Fullen, is justifiably proud of his equipment, probably his most valuable asset is his well-trained and loyal crews. Realizing several years ago the importance of competent personnel, Fullen established a hiring procedure which has resulted in a current personnel turnover of less than 1% per month.

When one of the rig crews needs a new man, the driller selects a candidate from the various applicants. This man is then interviewed at the company's main office and his references and work history for the previous two years are checked immediately by telephone. If his experience is favorable, he then must pass a thorough medical examination before finally being hired.

The company provides at no cost to the employee group insurance protection which includes life insurance, disability benefits, and hospital, medical and surgical benefits. Dependents of the employee can participate in the hospital, medical and surgical coverage under the group rates.

Such sound hiring practices and employee benefits have helped Mallard Well Service reduce personnel turnover from an average of around 16% per month in 1959 to less than 1% in 1961.

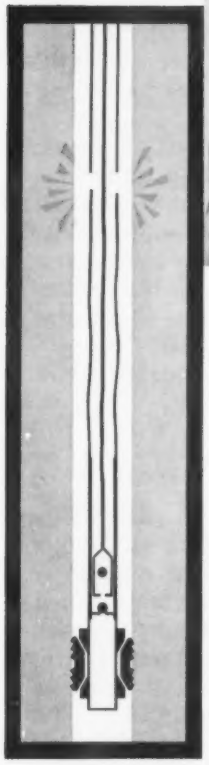
As drilling continues to go deeper and fewer new fields are found at shallow depths, the contractors equipped to work on these deep, high-pressure wells will be more and more in demand. Specifically, in the four coastal parishes of Southwest Louisiana, the average exploratory well drilled in 1960 was 13,500 ft deep. In 1959, this figure was around 13,200 ft.

It will take more than merely big equipment to service these wells. The successful well servicing and workover contractor, in this area or any other area of deep, high-pressure wells, will have specially-designed rigs run by well-trained men. He will be a sound technician and a good businessman — and a little bit of luck won't hurt him.

Lowell A. Murphy is associate editor of PETROLEUM ENGINEER.

■

"This no-movement slip-cone design makes the Baker Anchor-Catcher different..."



Catches Tubing Before it Falls!
No free fall should the tubing part. Possibility of a coincident rod part is greatly reduced.

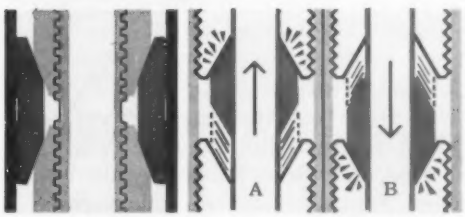
NEW BAKER TUBING ANCHOR-CATCHER COMPLETELY ELIMINATES VERTICAL MOVEMENT AT ANCHOR

Even deep wells can now be pumped more efficiently and with greater safety, because of Baker's "no movement" anchor-catcher principle.

Is no movement really important? It is... both in anchoring and catching tubing. This anchor-catcher stays exactly where you set it. Because it can't move downhole, it won't overstress tubing. Its positive, no-movement grip maintains the proper tension, once applied, to eliminate breathing and buckling... thereby reducing tubing and coupling wear and assuring maximum pumping efficiency.

The Baker Anchor-Catcher stays put—virtually catching parted tubing *before* it falls. The possibility of rod parts is greatly reduced and fishing jobs are simplified.

To learn more about the way in which this new Baker Anchor-Catcher (Product 698-B) can help you produce more oil at less cost, write for Bulletin 391. Baker Oil Tools, Inc., P.O. Box 2274, Terminal Annex, Los Angeles 54, California.



WITH A BAKER ANCHOR-CATCHER there is no movement after setting, because both cones are in full wedge-contact with the slips, which are in grip-contact with the casing.

CONVENTIONAL ANCHOR-CATCHER Insufficient tension may allow the cones to slam back and forth between the anchoring (A) and catching (B) positions during pumping cycle.

TUBING ANCHOR-CATCHER

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Corrosion Causes Unusual Workover

by Doyle L. Jones

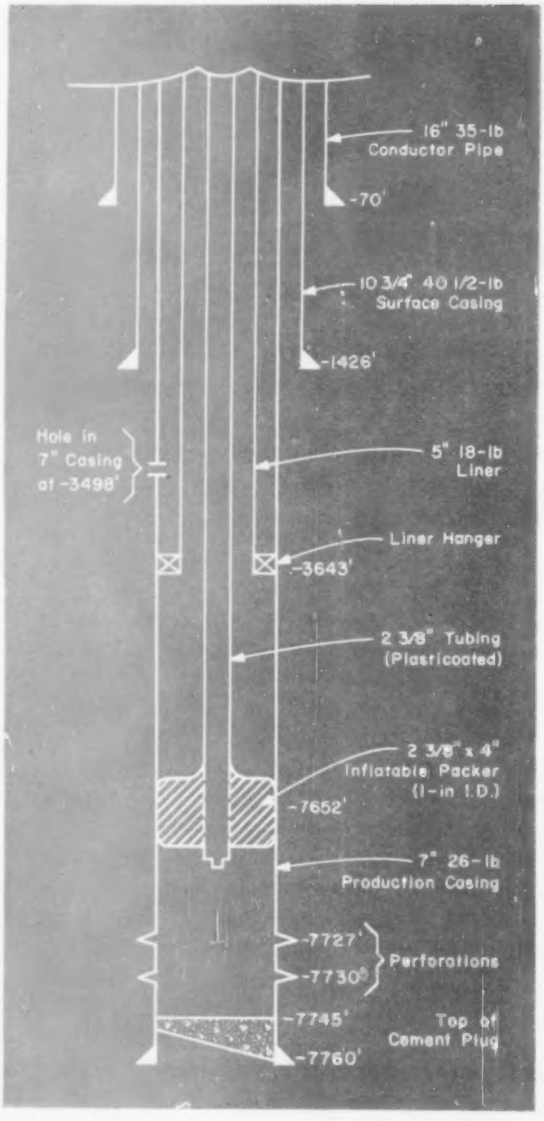

FIG. 1. Unusual solution to a difficult workover problem is schematically shown. Note how inflatable packer makes it possible to set tubing through a 5-in. liner and to packoff inside 7-in. casing.

What began as a simple job of inspecting one of the first plasticoated tubing strings in a South Texas field well turned into a complicated workover. Corrosion damages directly and indirectly resulted in:

- Setting a "scab" liner
- Unusual difficulty in killing the well
- A parted tubing string
- An unusual method of testing casing
- A unique method of packing off the tubing-casing annulus
- Replacement of the tubing string

This well produces oil, gas and salt water from the Upper Frio formation at 7730 ft. It was a conventional completion with 7-in., 26-lb production casing cemented to 7760 ft and top of the cement plug located at 7745 ft. The well was equipped with 2-in. OD internally-plasticoated tubing. The tubing was not packed off on bottom.

Original intent was to kill the well with mud, pull and lay down the plasticoated tubing for inspection, rerun the tubing, swab-in and put the well back on production . . . a simple pulling job in anybody's books! But, the job became more complex than ever expected. Subsurface corrosion had been at work and was found later to be much more severe than anticipated.

Final well hookup is shown schematically in Fig. 1.

Condition of Well

Upon going back into the well, the tubing string was found to be parted at about 1100 ft below the surface in a special type circulating valve used to unload the well after the last workover. After considerable difficulty, the well was finally killed with an 18-lb/gal mud. Corrosion damages had caused the tubing string to part in nine different places, complicating its removal from the hole. After days of fishing and pulling, most of the 2-in. tubing string was recovered except 1½ joints which were left on bottom.

After the tubing had parted at 1100 ft, the produced well fluid took the path of least resistance, which was into the annulus. Over an extended period, corrosive fluids in this well stream caused extensive corrosive damage to the outside of the tubing and probably to the internal surfaces of the production string of casing. After the 2-in. tubing was removed, the plasticoated internal surfaces were found to be in excellent condition as indicated in Fig. 2. Outside condition of the tubing string is also indicated in this figure, as well as in Fig. 3 which depicts the condition of a recovered

GOOD MEN GOOD TOOLS

Baker provides the right tool (or tools) and accessories for any remedial or stimulation job.

1 Baker Retrievable Full-bore Cementer (Product 410) is an important squeeze cementing, fracturing, acidizing, testing packer. It is teamed with **2** Baker Retrievable Bridge Plug (Product 677-C) in straddle operations, either single-zone or selective multiple-zone. Cementer and Plug together can straddle a virtually unlimited distance. And any number of zones can be treated in one round trip. **3** Baker Drillable Cement Retainer (Product 400) sets the industry standard for dependable high-performance squeeze cementing. **4** Baker Drillable Wire Line Bridge Plug (Product 400-N) is the industry's most available and most reliable bridge plug.

Dependable remedial and stimulation service demands both. Baker offers both.

YOU ARE LOOKING at four of the most respected well-service tools in the industry. They command respect because their performance is consistent and reliable. They have proved themselves in thousands of critical downhole operations.

Simplicity is important in service tools. A simple tool is a reliable tool—and it is easier to control when it's in the well. Simplicity of design is one important reason for the success of Baker service tools.

YOUR BAKER SERVICEMAN lives and works in your area—and he knows the well-service problems of your area.

His local knowledge is vital. It helps keep him—and you—out of unforeseen situations. It helps him sense trouble before it starts. It guides him—and you—when you get into something you couldn't anticipate.

A Baker Serviceman does his work with confidence and authority. He knows his area, and he knows Baker tools. He's a tool specialist. Baker tools are his *only* business. He's a good man to call for your next remedial or stimulation job.

BAKER REMEDIAL AND STIMULATION TOOLS

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FIG. 2. Inspection of tubing revealed that plasticoated internal surfaces held up well under severe corrosive conditions. Un-coated external surfaces of tubing were damaged critically.

FIG. 3. Deteriorated condition of tubing joint with recirculating valve which had parted at about 1100 ft below surface. What appears to be mud is actually corroded metal.

tubing joint and the circulating valve that had originally parted in the string at about 1100 ft.

A leak in the casing or liner, or possible communication behind the liner, was suspected, because of extensive corrosion damage to tubing and loss of mud while circulating to kill the well. In the previous workover of this well, a 5-in. OD 18-lb liner had been set from the surface to 3654 ft inside the 7-in. production string as shown in Fig. 1.

Normal practice would have been to run a packer and pressure-test the casing. But, in this case, the internal diameter of the liner through which the packer must pass was only 4.118 in. Below this liner is 7-in. casing with an ID of 6.776 in., in which the packer is set. Several wire line tests were run to locate the suspected leak, but these tests were not conclusive.

Decision was made to attempt a pressure test using a 4-in. inflatable production-injection packer rather than to pull the liner and pressure-test with a conventional packer. The inflatable packer was run on 2-in. tubing through the 5-in. liner and then set below it in the 7-in. casing at 7640 ft. The annulus was pressure-tested to 1500 psi for 30 min, which proved no leaks or communication.

Because such a relatively large volume of mud (about 300 bbl) had been lost in the formation, it was decided to run gas-lift valves in the tubing string to unload and clean up the well, then remove it after several weeks of production. After the casing was tested, the packer was pulled from the hole, re-dressed and run in on a string consisting of 249 joints of $2\frac{3}{8}$-in. plasticoated tubing equipped with gas-lift valves. After setting the packer below the 5-in. liner in the 7-in. casing to 7652 ft, the well was unloaded and tested for several days.

The packer failed because of high differential pressure across it (about 1100 psi) after unloading the annulus to 3100 ft through the gas-lift valves. Differential across this packer was limited by the large ratio of expansion from its 4-in. OD size to 6.776 in. ID of the 7-in. casing.

Packer, tubing and gas-lift valves were pulled and packer re-dressed and re-run on the $2\frac{3}{8}$-in. tubing. The packer came back into the liner with no difficulty.

The well was swabbed in and has been producing for several months with zero casing pressure.

Corrosion, a major production problem in this particular field, is controlled by completely plasticoating internal walls of tubing strings and by isolating casing-tubing annulus. Each well is tested every three months for tubing string leaks as a further safeguard against casing and external tubing corrosion. If a leak is found, the well is worked over immediately.

Acknowledgment

Days of anxiety, sweat, planning and figuring went into this briefly described workover case. Thanks are expressed to those who participated in it, and to Vernon Stewart, Lynes Inc., who worked out the inflatable packer solution.

Doyle L. Jones is a petroleum engineer for The Ohio Oil Company at Bay City, Texas.

■

Q-BROXIN*

ALL-PURPOSE MUD THINNER

Ferrochrome lignosulfonate

Q-BROXIN, after six years of successful field use, is still the most useful and versatile mud treating chemical since quebracho was first used many years ago. Q-BROXIN made it possible to thin, de-gel and control filtration in fresh water mud, salty mud and calcium contaminated mud. Q-BROXIN does not require a narrow pH range for continued efficiency in any mud.

Use Q-BROXIN for controlling viscosity, gels and filtration—

- in fresh water mud
- in salty mud
- in gypsum mud
- in hot muds
- in high pH muds
- in low pH muds
- in any weight mud

also—

- for emulsifying
- to breakover and maintain lime mud
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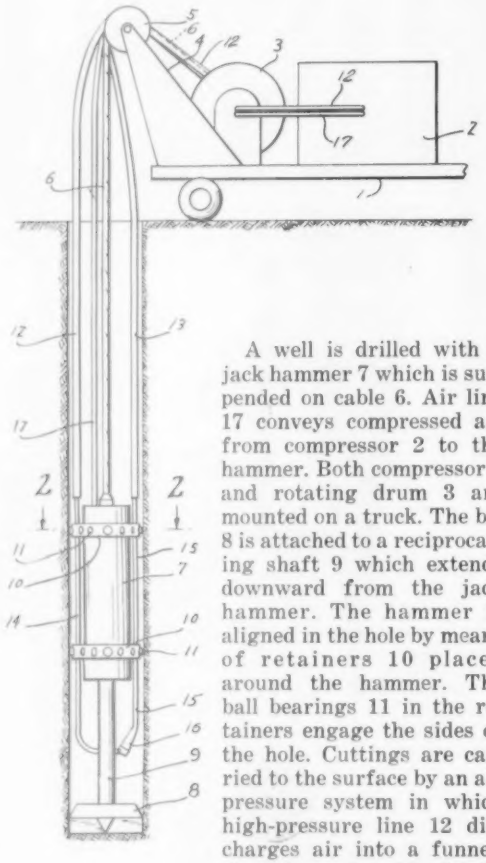
What's New in Patents

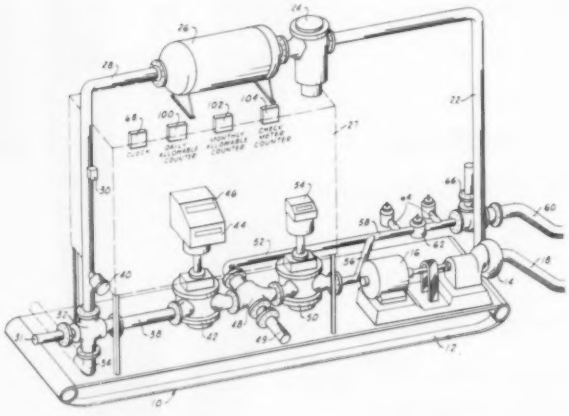
Wells Drilled With a Jack Hammer



A well is drilled with a jack hammer 7 which is suspended on cable 6. Air line 17 conveys compressed air from compressor 2 to the hammer. Both compressor 2 and rotating drum 3 are mounted on a truck. The bit 8 is attached to a reciprocating shaft 9 which extends downward from the jack hammer. The hammer is aligned in the hole by means of retainers 10 placed around the hammer. The ball bearings 11 in the retainers engage the sides of the hole. Cuttings are carried to the surface by an air pressure system in which high-pressure line 12 discharges air into a funnel-shaped opening 16 of tube 15 which is connected to low pressure line 13. Patent No. 2,997,120, Method of Drilling Wells and Apparatus Therefor, J. T. Kendrick.

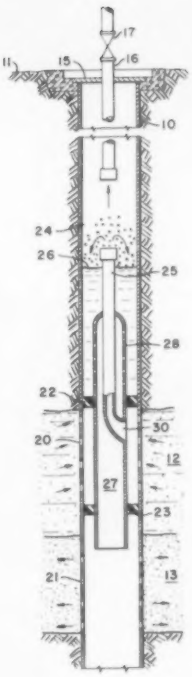
Checks Production Meter Periodically

A means of periodically checking the performance of the production meter 42 in a lease automatic custody transfer system is provided. A check meter 50, is connected in series with the production meter. Once a day, for example, oil flow is run through both meters for a limited time. At the end of that time, the check meter is bypassed or cut out of the oil flow line. If there is a substantial error in the production meter, this method detects the degree of difference automatically. An alarm system is provided along with controls for stopping flow of production fluids through the system. Patent 2,958,218, Automatic Custody Transfer of Crude Oil, R. W. Hill.



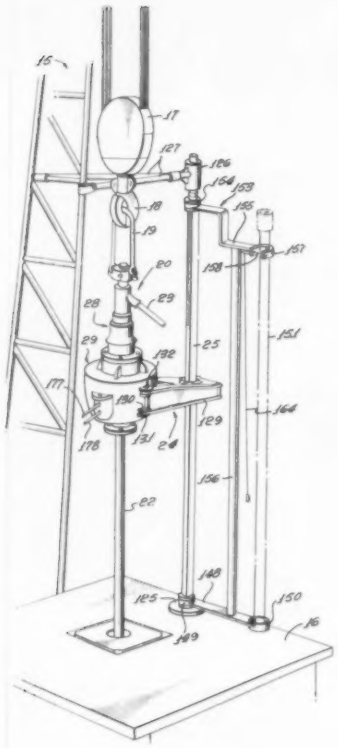
These patents were selected by Paul H. Johnson and James R. Head, patent attorneys in Tulsa, Okla. If you want a copy of these patents for further study, write the Commissioner of Patents, United States Patent Office, Washington, D. C. Price is 25¢ for each copy.

Down-Hole Separator For Flowing Wells



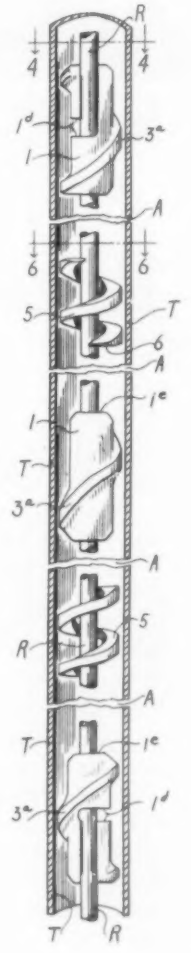
A down-hole system simultaneously separates salt water from produced hydrocarbon fluids and injects the water into formations located either above or below (as shown in sketch) the producing formation. The apparatus is for particular use with flowing wells where combined production fluids rise vertically through a production standpipe within the well. As the mixture of hydrocarbon fluids and water are discharged at the open upper end 25, its velocity is reduced. The water drops out into a reservoir 26 while the hydrocarbon phase moves upward within the well where it is recovered by well known methods. The separated water flows downward through a special bypass conduit 27 around the vertical riser and is discharged into a lower formation 13. Patent No. 2,986,215, Salt Water Disposal System, C. L. Barr.

Hydraulic Swivel Eliminates Rotary Table



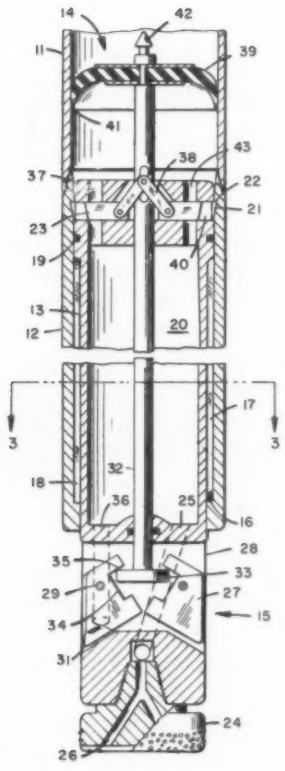
An hydraulic power unit powered by fluid flowing through conduits 177 and 178 rotates the drill string. Attached to the power unit 29 is a torque arm with a sliding connection to column 25. Drilling mud circulates through flexible hose 23. The device is raised and lowered by a traveling block 17. The idea eliminates the usual rotary table and kelly in drilling operations to speed up rotary drilling of wells. Patent No. 2,998,084, Fluid Operable Power Device for Well Operations, G. D. Johnson, et al.

Combined Scrapers Remove Paraffin



This paraffin remover combines both fixed and movable scrapers which are alternately spaced along the sucker rod. The fixed scrapers 1 clean the inner surface of the tubing and contain the travel of the movable units 5. The latter scrape the inner walls of the tubing as well as outer surfaces of the sucker rod and prevent build-up of paraffin on either surface. Both scraper elements are made of plastic. The movable scrapers spiral around the rod and provide a "screw action" as they move up and down with the reciprocating motion of the sucker rod. The fixed scrapers are frictionally attached to the rod with a unique system of slots. Patent No. 2,997,106, Paraffin Scraper Combination, J. C. Tripplehorn.

Drill Bit Is Retrievable



A wire line retrievable drill bit is described in this patent. The free drill bit assembly 15 is lowered into a drill pipe and locked in a special seating collar at the lower end of the pipe. A cup-type piston 39, operated by drilling fluid pressure, locks the assembly in position and expands portions of the drill bit 27 outwardly to drill a hole of a diameter larger than the outside diameter of the pipe. Drill fluid pressure and piston design are such that leakage occurs past the piston into the drill bit assembly to circulate through fluid channels 25, 26. Patent No. 2,997,119, Drill Bit Assembly, L. O. Goodwin.

Reconditioning unit treats lubricating oil from the gear box of a large pumping unit. Portable reconditioning unit includes steam cleaning equipment.

Better Lube Oil Care = Big Savings

Economy-minded operators are extending cost-reducing procedures to include better care of oil field lubricating oils. Not only is it simple to test the condition of lube oils in the field, but the oil can be reconditioned on-the-spot by portable equipment.

Such a program offers enormous potential savings, according to Bob Reekstin of R & W Engineering Service Co. and Mayhew Products Co. of Los Angeles, Calif. After all, it can be said that each $1 saved in the field is the pocketbook equivalent of selling $17 worth of petroleum products.

A kit, which costs less than $100, is used to test periodically the condition of lubricating oil. Small, portable oil reconditioning units can be towed by pickup truck or car to do the job on location with minumum equipment down-time.

Thousands of dollars in lubricating oil can be saved and equipment maintenance and repair drastically reduced, Reekstin reports.

He points out that a gear reducer on a beam pumping unit holds from 5½ to 35 gal (and more on the big husky pumpers). Engines that drive these pumpers take from 3 to 17 qt each.

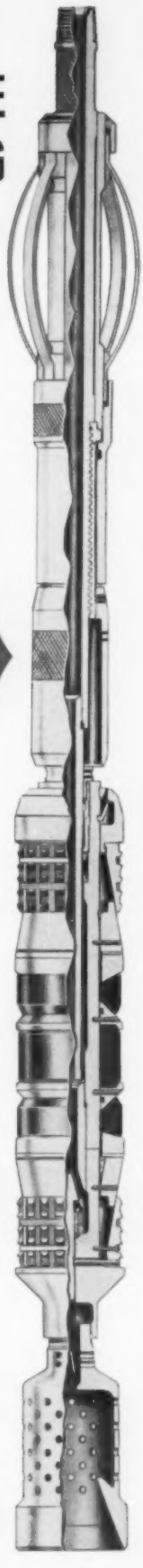
This may not sound like much, but consider that of the 600,000 producing oil wells in the U. S., 530,000 are produced by some means of artificial lift, mostly by beam pumping units.

Even gas lift wells that account for about 20% of the artificially lifted wells require large compressors driven by big engines. These compressors and engines each hold from 20 to 30 gal of lubricating oil.

Some of the larger engines used in drilling need from 20 to 30 gal each. A rotary table uses

SQUEEZE CEMENTING WITH FIRST TIME DEPENDABILITY

Downtime is no time for wasting time. When Halliburton is performing your squeeze cementing job you expect the job to be done quickly, efficiently, and *thoroughly*. All the care and skill at our command are used to help produce successful squeeze cementing results for you the *first* time. Whether you are squeezing perforations to isolate a payzone, repairing a casing leak, sealing a low pressure thief zone, plugging to abandon a zone or well, or correcting a channeled primary job, depend upon Halliburton's experience spanning over 35 years of successful squeeze cementing.

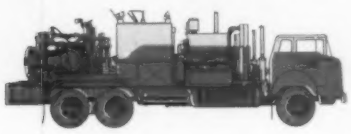


DM/DC Squeeze Packer

DM/DC SQUEEZE PACKER
designed for first time dependability

Compare these operator-approved features with any other squeeze packer:

- *Built-in Back Pressure Valve* – keeps tool open for circulation or reverse circulation at any time while running in. The valve closes after packer is set to shut off back flow. Sealing cup-type valve affords a more positive seal.
- *Free from Packer* – Circulating Valve and tubing are free from packer before squeezing begins and may be picked up between stages as desired. Tubing and Circulating Valve may be withdrawn from the well at any time to repair a tubing leak and then re-enter the packer.
- *Multiple Setting Techniques* – tool may be run and set on tubing, drill pipe, sand line, drilling line, or electrical logging wire line.
- *Convertible to Bridge Plug* – easily, efficiently. A Permanent Sealing Plug may be installed in the tool at the surface . . . a 15/16″ bridging ball or Sealing Plug can be dropped down the tubing into a seat in the packer . . . or a Shut-Off Sealing Plug which shuts off in the packer may be pumped down the tubing behind cement and ahead of displacing fluid to help prevent cement contamination.



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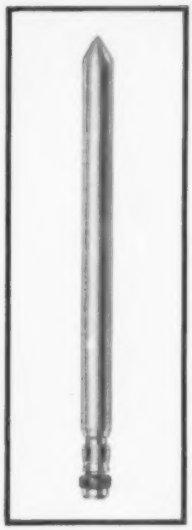

Weighted Sealing Plug

Shut-Off Sealing Plug

Permanent Sealing Plug

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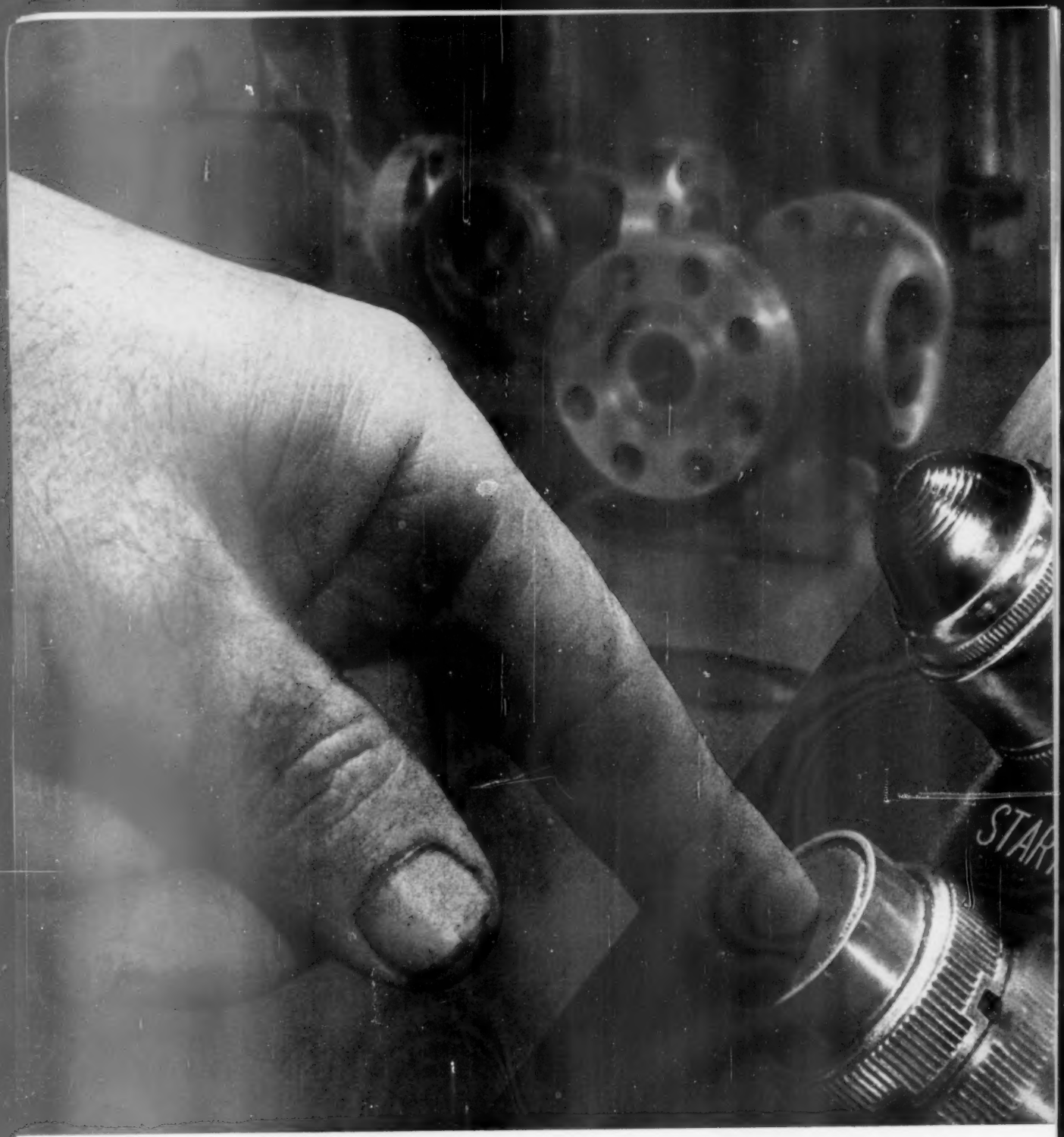

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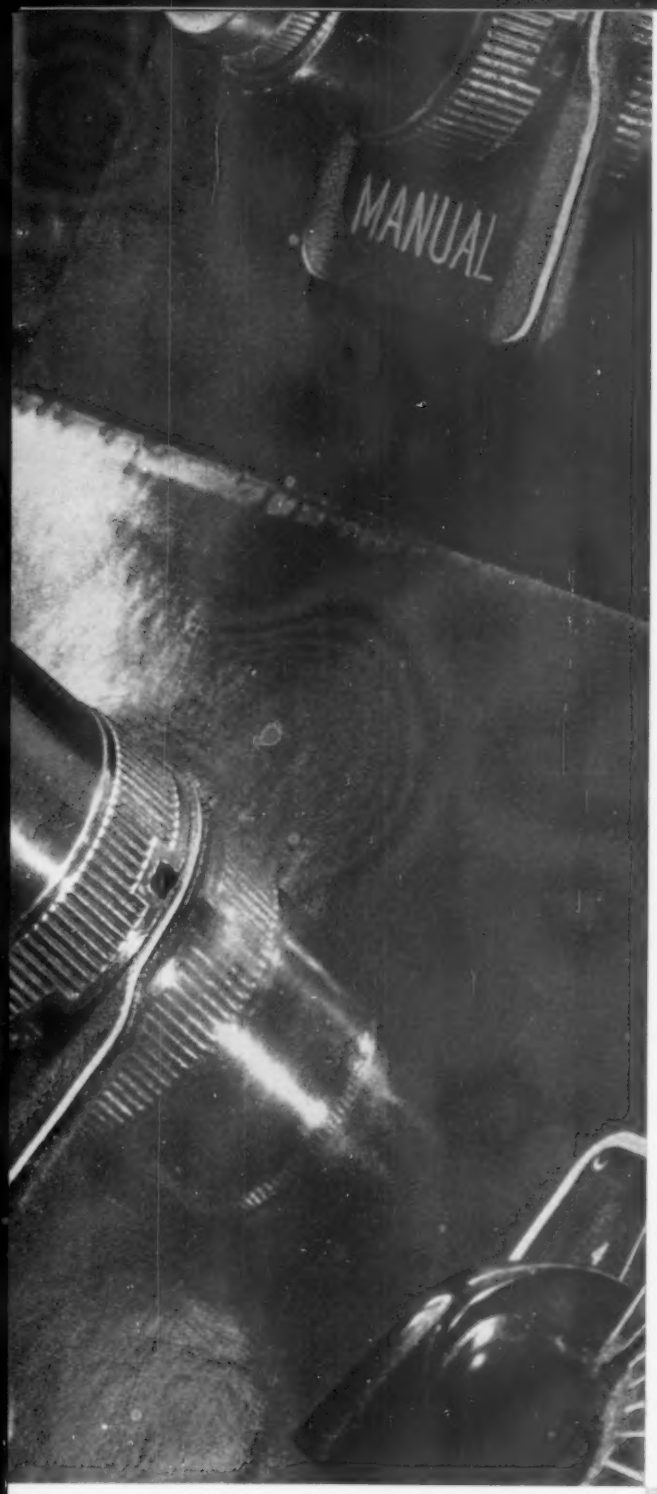

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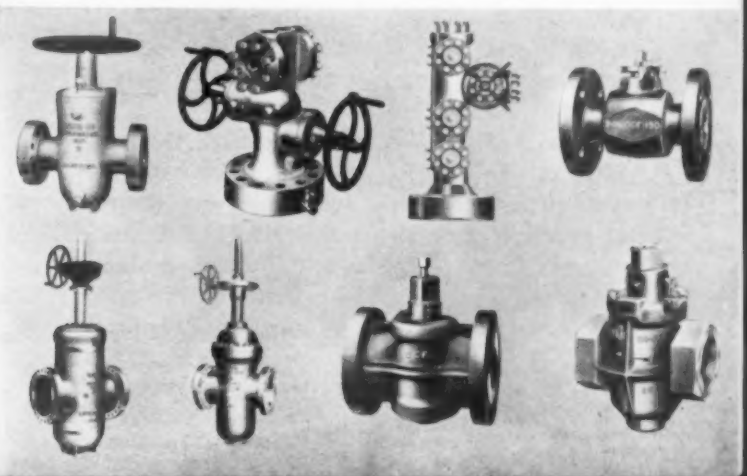
This is just one example of the many continuing efforts by W-K-M engineers to go beyond "just the necessary" to bring you the best possible valves through highly creative approaches to difficult engineering and manufacturing problems. And who benefits from W-K-M's creativity in action? You do . . . of course.

When So Much Depends On a Valve

. . . *Specify* W-K-M



from 8 to 18 gal, while mud pumps hold up to 50 gal of oil.

These are but a few examples. When you look at all the equipment using lubricating oil in the field, the cumulative volume is quite large. This equipment operates under the most severe conditions known . . . out in the open where it is subject to heat, cold, dust and rain. Lubricants keep bearings, gears and cylinder walls cool as well as reduce friction to a minimum.

In dissipating heat at these "hot spots," minute quantities of the lubricating oil are cooked, carbon forms and the oil begins to break down. Once this breakdown starts, a reaction begins. Products of unstable hydroperoxides form first; then they react to make acids, alcohols, aldehydes and ketones . . . all soluble in oil. Insoluble gum, sludge and varnish is formed from polymerization and condensation. Both the soluble and insoluble products are extremely harmful to any lubricating system. Viscosity is increased . . . metallic corrosion takes place . . . sluggish operations result along with wear of close-fitting parts and plugging of valves, strainers and orifices.

At this point, the original qualities of the lubricant are lost. The oil film no longer may be able to support the load on the bearings, additional heat is generated and bearings are destroyed. Gear faces are no longer protected by an oil film, metallic contact is generated, heat and accelerated wear occur. The end result of all this is equipment down-time, high operating costs and loss of production.

Changing oil frequently will solve the problem. This is expensive, for many systems require not quarts of lubricant, but gallons, some even several hundred gallons.

Field Testing, Reconditioning

This high cost can be reduced by periodically testing and reconditioning the oil without moving the equipment. Frequency of tests depend upon equipment service. For example, gear boxes on beam type pumping units may require testing only once or twice a year. Hydraulic systems operating at temperatures below 130 F fall in the same catagory. Any system operating above this temperature should be tested more frequently.

These field tests indicate condition of lubricating oils and include viscosity, acidity, water and solid content. Each subsequent test shows the rate of oil deterioration. Acidity is indicated in terms of a Neutralization Number. An accepted rule-of-thumb is to tolerate an increase of 0.3 in this number. Lubrication engineers recommend only a 1% solid contaminant rate before removing the oil.

Complete oil testing kit for field use determines condition of lubricating oil.

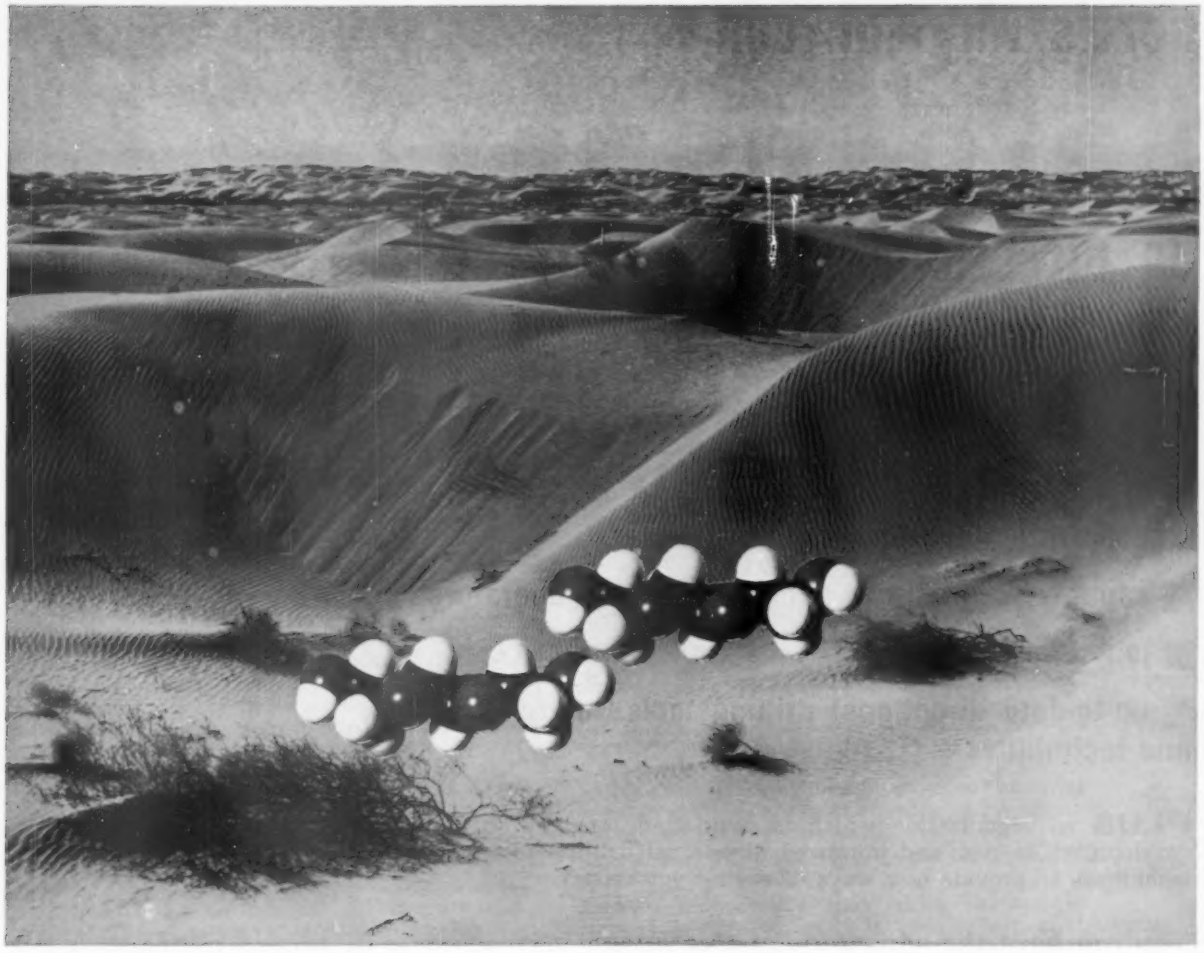
Portable oil reconditioning units have extended the useful life of lubricating oils from two to four times its normal usage. Reconditioners work on a principle of mechanically and chemically separating from the oil all harmful solids, water and acids. Contaminants are collected on the surface of particles in the filtering medium by mechanical and chemical attraction. Fullers earth, charcoal, silica gel, activated alumina and bauxite are typical filtration materials used in oil reconditioners.

System Cleaned Too

In an oil reconditioning program, both the oil and the system must be cleaned of contaminants. For this reason, oil reconditioning units include steam cleaning equipment. If these contaminants are not removed from the system, they will react as a catalyst and increase the rate of oil deterioration. Steam is also used to heat the oil to improve filtering and separation of water.

Time required for oil conditioning and steam cleaning the system is not much more than required to make a complete oil change. Operation is simple. Used oil is completely evacuated from the lubricating system into a storage tank on the reconditioner. While the oil is reconditioned, the system is steam cleaned. By the time the system is cleaned, the oil is conditioned and pumped back into the lubricating system.

You can be dollars ahead if you test your lubricating oil periodically, recondition it when necessary, clean the system at the same time, and operate the equipment according to the manufacturer's ratings. ■



THIRSTY MOLECULES These are molecules of triethylene glycol (TEG), the liquid desiccant widely used in Glycol Dehydration Units for dehydrating natural gas to pipeline specifications or for further processing. When fairly dry (that is, in concentrations better than 98% by weight) TEG becomes exceptionally thirsty and is eager to absorb water vapor from gas by contact. However, like animals and people, TEG becomes increasingly thirsty the dryer it is. Therefore, the dewpoint depression possible with a glycol dehydration system is mainly dependent on the efficiency of the glycol regenerator in drying out (reconcentrating) the glycol after it has picked up water through its contact with the gas stream in the absorber.

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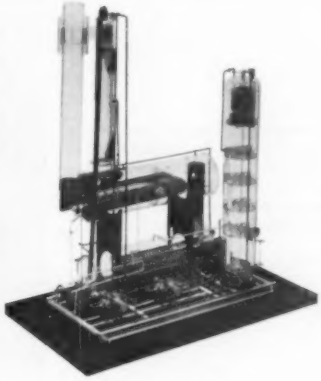

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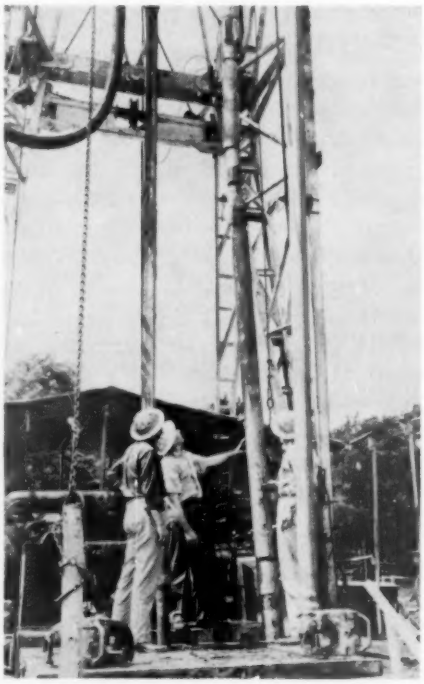

Typical example of Eastco's research and development is the current program of research and field testing to determine the benefits and costs of turbo directional drilling when applied to various drilling problems.

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A Visco PRODUCT MANAGER Answers Questions on Clarification for Open System Waterflood and Salt Water Disposal Units

Effective Clarification Lowers Water Treatment Costs, Ups Operating Efficiency

Successful waterflood operation is heavily dependent on good clarification practices to keep injection wells and formations from plugging, raising pumping pressures and cutting input volumes. Here are a few of the most-frequently-asked questions about clarification, and answers which may be helpful to you.

Question: What is the difference between clarification and coagulation?

Answer: Clarification is the process of removing turbidity and finely-divided particles from water. Coagulation is one of the ways to achieve clarification: gathering the finely-divided particles into clumps or "flocs" by means of chemical coagulants to speed settling. Other commonly-used means of clarifying water are filtration and slow settling without use of coagulants.

Question: Do you know beforehand which coagulants will work best in any particular water?

Answer: Generally, no. Coagulation occurs when electrical charges on turbidity particles are neutralized. These charges vary considerably, depending on the characteristics of the turbid water. Chemicals which will form good, dense, heavy floc in one water may be slow-acting and ineffective in another. The best way to be sure that the proper coagulants are being used is to "jar test" a number of coagulant chemicals in the water to be clarified.

Question: What is jar testing?

Answer: Jar testing is a multiple testing of turbid water samples with all known coagulants, singly and in combinations with each other, to determine which coagulants are most effective and economical to use in the specific water.

Product Manager Don Oleen demonstrates jar testing technique used by Visco water injection specialists. It is the sure way to get exact data on the coagulants and coagulant aids best suited in performance and economy for the specific injection water being used.

Don C. Oleen, Product Manager, Visco Waterflood Chemicals Department, is among the best qualified men in the petroleum industry to answer questions and solve problems in waterflood treatment.

Question: When and where should jar testing be done?

Answer: Immediately upon taking the sample, right at the flood where the water is to be treated. Turbidity in water samples used for jar testing coagulants will partially or wholly settle out if samples are not tested immediately. A coagulant which appears to do a good job on water samples taken hours or days before may be expensive, inadequate, or both when used at the waterflood location.

Question: Can Visco jar test the injection water for my waterflood system?

Answer: Yes. All Visco water injection specialists are equipped and trained to run jar tests at flood or salt water disposal locations . . . And this service is available *only* from Visco.

Question: What about the time and costs of jar testing?

Answer: Jar testing is a Visco service, provided without charge by Visco water injection specialists. A phone call or letter to your Visco Representative will bring a specialist to make jar tests and give you recommendations as to the coagulant chemicals which will do the best clarification job at lowest cost on your injection water. Time to call Visco is now.

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Visitors to the oil show had to step lively to see the many exhibits. Other special events during the show kept the estimated 250,000 visitors busy day and night.

LOUISIANA OIL SHOW ATTRACTS THOUSANDS

The fourth biennial Louisiana Gulf Coast Oil Exposition, held in Lafayette, Oct. 19-22, turned this Gulf Coast oil industry supply center into a huge specialized fair grounds. An estimated 250,000 visitors came to see the latest products and services being exhibited by some 215 companies.

Created in 1955 by Lafayette oilmen and other volunteers, the exposition, commonly referred to by its initial-name LAGCOE, is held every other year, alternating with the Permian Basin Oil Show in Odessa, Tex.

After a colorful parade of equipment through the streets of downtown Lafayette, the show

Honorable Jimmy H. Davis, governor of Louisiana, mans the shears to open the fourth biennial Louisiana Gulf Coast Oil Exposition. LAGCOE officials join the governor in the opening ceremonies.

More than 200 companies exhibited their products and services at LAGCOE. Billed as "The Working Man's Oil Show," LAGCOE is one of the three largest oil and gas industry expositions.

A miles-long parade of oilfield equipment through downtown Lafayette kicked off the show. Exhibitors from all parts of the country showed off their equipment in the colorful procession.

Working demonstrations of oilfield equipment provided plenty of noise and bustle on the grounds of Blackham Coliseum. This fracturing unit, powered by a gas turbine, was a popular exhibit.

was officially opened by the governor of Louisiana, Jimmy H. Davis. Governor Davis welcomed visitors to the show from all over the nation and acknowledged the major role played by the oil industry in the economics of the state and especially of the Gulf Coast region. Louisiana operations account for 24% of all money spent in actual drilling and equipping of wells in the United States. One out of every five non-agricultural workers in the seven-parish Lafayette territory are employed in oil and gas production.

A series of special events staged by LAGCOE added to the excitement of the show. A Cajun shrimp boil featured two tons of shrimp. A barbecue for 5000 persons was prepared and served by the famous Chuck Wagon Gang from Odessa, Tex. Noted news analyst Paul Harvey spoke at a huge luncheon, and five judges had the difficult task of choosing a new Queen LAGCOE from among 27 "petroleum princesses" sponsored by Louisiana parishes and by companies in the industry.

While LAGCOE provides many opportunities for social activities and business contacts, it is intended primarily as a chance for working oil men to become better acquainted with the tools available to help them do their jobs. As such, the show has become known as "The Working Man's Oil Show." ■

Portable rig in background is used to drill large holes at missile bases in Kansas. The 40-in. diam limestone core has just been lifted from the core barrel by a crane.

Portable Rig Drills Large Holes at Missile Sites

A portable rotary rig is being used to drill 42-in. holes by a continuous coring method at missile bases in Kansas. Three holes at each of 18 sites will be core drilled by this truck-mounted Failing Blastmaster which is moved from one hole to another at each site in an average time of 1½ hr. Rock formations penetrated and locations of the holes in the construction excavations, as well as the 3½-ft diam size of the holes, combine to create a unique drilling problem.

Holes are drilled in sedimentary rocks of Permian age. At some sites, marine Fort Riley and Florence limestones are encountered. The Florence flint of the latter is extremely cherty and very tough. At other sites, the formations are non-marine red and green shales and gypsum of the Sumner Group. Some holes are dry all the way. In others, there are varying amounts of water and numerous lost-circulation zones.

Straight rotary drilling with cone-type bits and a conventional oilfield rig were ruled out because of the large size of the holes, their closeness to the launch silo and control center at each site and various complicated operational problems.

A small portable rig was the answer to the problem of limited working space available in and around the cellars, which are 30 ft deep, 28 ft long and 20 ft wide, and the other operating difficulties. To set the rig in drilling position, the truck-mounted unit is placed on two portable steel girders which span the deep cellars.

Core barrels are fabricated from ⅜-in. hot-rolled steel stock. The one for the softer drilling is 4 ft long and has a 6-in. hole for a 6-bolt flanged connection. It has two spiral flights of ½-in. key stock on the outside, bottom to top, and six cutter blocks faced with tungsten carbide on the bottom rim. Sumner shales are cut at the rate of 5 ft per hr using air.

For the cherts and limestones, the barrel is smooth-sided and has a 7-in. shoe of ⅝-in. hot-rolled bar stock on the bottom. Various sizes of chilled shot are used to speed drilling. The barrel is rotated at speeds from 12 to 60 rpm with or without air and pulldown pressure. Limestones are penetrated at the rate of 18 to 40 ft per min. Total drilling costs in the limestone areas run about $21.50 per ft.

After cutting cores to the depth to fill a barrel, the latter is pulled and set aside. A small hole is then drilled through the center of the core for attachment of a lifting rod.

Most cores must be jarred to break them loose. This is accomplished by detonating a primacord at the bottom of the cut. Some of the shale cores and a few of the limestone cores pull loose along natural parting lines in the formation. ■

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Lloyd E. Elkins

Harold F. Winham

Awards, New Officers Highlight Engineers Meeting

Top honor awards and election of new officers featured the fall meeting of SPE of AIME. Harold F. Winham, district manager, New Orleans div., Shell Oil Co. since 1948, received the society's 1961 Certificate of Service. Another top honor of SPE — the John Franklin Carll Award in recognition of "distinguished achievement in or contributions to petroleum engineering" — went to Hallan N. Marsh, California petroleum consultant, Whittier, Calif.

Fred H. Brinkman, Jersey Production Co., Tulsa, Okla., was awarded the Cedric K. Ferguson Medal for the "most outstanding paper presented in 1960 by a Junior Member of SPE." Co-author of the paper was J. N. Sicking of the same company who received a special certificate for his work because he is not a junior member of the society and thus was not eligible for the medal.

New president of AIME for the term starting in February 1962 is Lloyd E. Elkins, production research director for Pan American Petroleum Corp., Tulsa, Okla. He was nominated for the position by SPE, of which he is a past president. He also has served as board member and vice president of AIME.

Two other SPE members were elected 1962 vice presidents of AIME. They are: Herbert F. Beardmore, vice president of Gulf Oil Co., Houston, Tex.; and Earl M. Kipp, special consultant-producing problems on the staff of the vice president in charge of producing and exploration, Standard Oil Co. of California, San Francisco, Calif. Douglas Ragland, engineering manager for Humble Oil & Refining Co.'s Humble Div., Houston, Tex., was elected to the AIME board of directors for a 3-year term beginning in 1962.

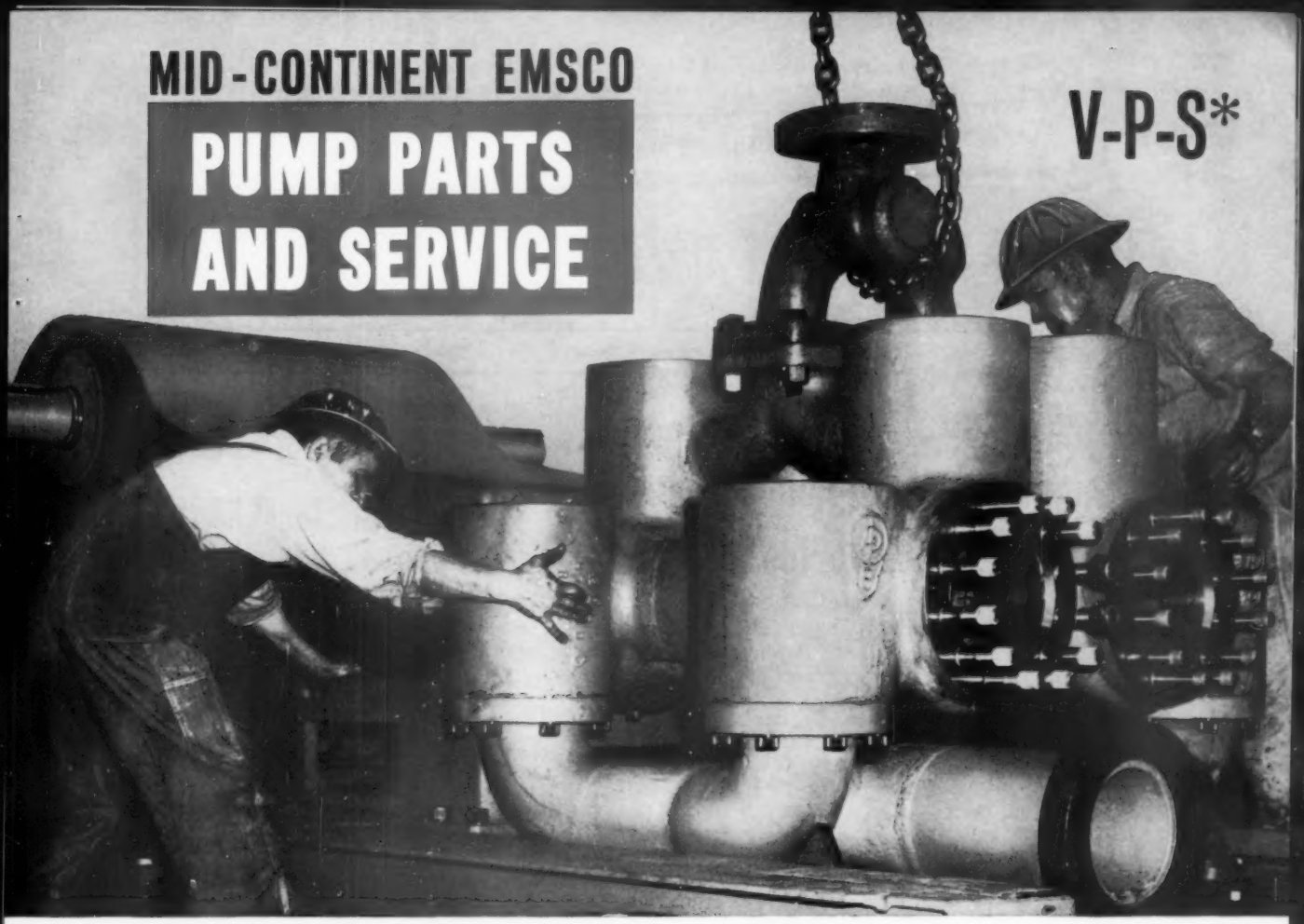
Richard A. Morse, associate director of research on oil and gas production and transportation for Gulf Research & Development Co., Pittsburgh, Pa., will be the new president of SPE of AIME. He will take office in February, 1962.

New members of the SPE board of directors include: E. S. Morris, vice president of Amarillo Oil Co., Amarillo, Tex.; Herman A. Engel Jr., coordinator of economics and evaluation for Union Texas Natural Gas Corp., Houston, Tex.; John M. C. Gaffron, assistant to the vice president of Freeport Oil Co., Div. of Freeport Sulphur Co., New Orleans, La.; Ivan Tucker, district superintendent for The Atlantic Refining Co., Corpus Christi, Tex.; William R. Waag, assistant vice president in the oil and gas department of Empire Trust Co., New York City; and Jimmie D. Harrington, Crawley and Harrington Consulting Firm, Fort Worth, Tex.

The SPE of AIME held its 36th annual fall meeting on Oct. 8 to 11, 1961, in Dallas, Tex. More than 100 technical papers concerning new developments in the drilling and recovery of oil and gas provided the largest technical program in the history of the society. Final registration showed that more than 2500 engineers attended the meetings and social events of those four days. Meetings were held in Dallas Memorial Auditorium.

Concurrent technical sessions covered such subjects as automatic production control, well logging, cementing and fracturing, water flooding, offshore drilling, mud technology, natural gas storage, gas injections and other topics. Authors of the papers represented 54 companies and 14 universities.

Displays and demonstrations by service and manufacturing companies occupied space in the south exhibits area of the auditorium. Many exhibitors displayed new oilfield equipment for the first time. ■



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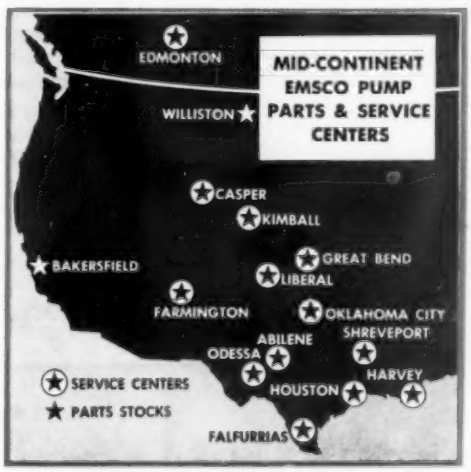

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Better Production Tools Through Research

OTIS Equipment NEWS

Volume III, Number 4 **Otis Engineering Corporation • Dallas** *Production Equipment and Services*

New Low Pressure Pilot System Offers Simplified Multi-Point Protection In Surface Safety Valve Installations

DALLAS—Two new Otis Pilots have been developed that make possible a well safety system that includes: (1) Multi-point protection utilizing a low pressure control line and (2) Single point, single step resetting to place the entire system back in service after a shut-in. The two new pilots are the Type N Otis Actuator Pilot and the Type P Otis Hi-Lo Auto-Reset Pilot. Both can be used with any one of several different Otis Surface Safety Valves.

A Type N and P Otis Pilot System, when combined with the proper Otis Surface Safety Valves, may be installed to protect a single well or a number of wells such as may be located on an offshore platform. The simplest installation is where a low pressure line connects the Type P Pilots at the point where protection is desired and the Type N Pilot on the safety valve. With this type of hook-up pressure changes from the flow line, sales line, heaters, separators, etc. are automatically transmitted from the Type P pilot to the Type N Pilot and Safety Valve.

Evidence of the acceptability of the new Type N and P Otis Low Pressure Pilot System within the various levels of field operating personnel, from superintendents and engineers through pumpers and gaugers, is indicated by the large number of installations made during the short time the equipment has been available.

Application

The application of the Type N and P Otis Pilot System is practically unlimited — from a single well, simple line pressure installation to a complex, multiple well installation that requires a number of protection points for various conditions that could cause serious loss.

Basically the Type N and P Otis Low Pressure Pilot System is designed to monitor pressure increases or decreases at such points in a surface safety installation as line pressure, separator, LTX unit, free water knockout, heat exchanger and other field processing or production equipment. The system may be installed to monitor various other conditions, also, such as liquid levels, high or low temperatures, volume, viscosity, etc. Electrical control of the system — radio, direct wire or microwave — can be added through the use of solenoids and other electrical equipment. A typical installation, in schematic form, is below.

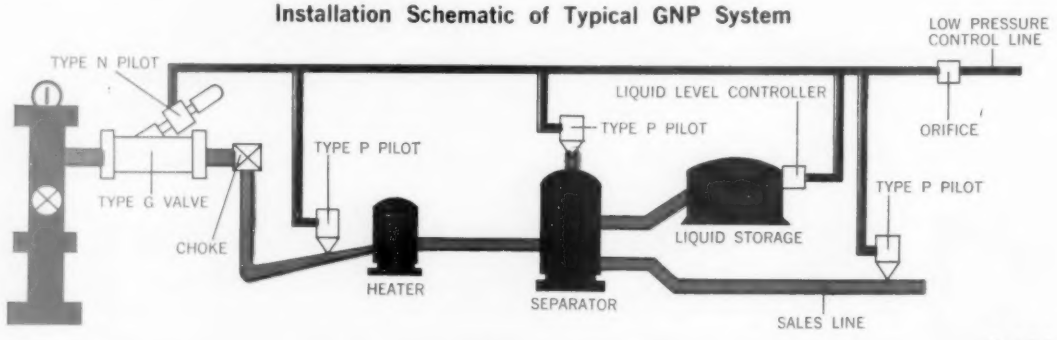
Here are several of the System's Feature Design Principles —

Low Pressure Control Line

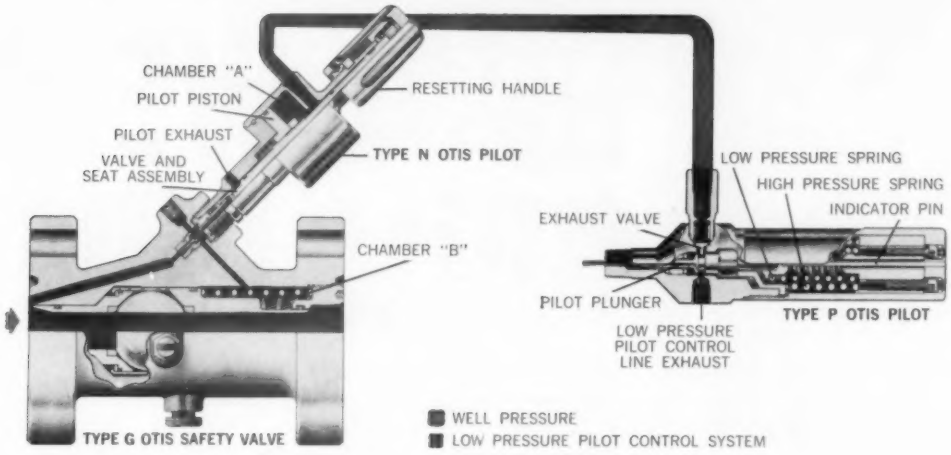
The Type N and P Otis Safety System is designed around the use of a low pressure (usually 30-60 p.s.i.) control line that connects the Type P Monitor Pilots with the Type N Actuator Pilot attached to the safety valve. The use of the low pressure line all but eliminates the possibility of hydrates forming and freezing the line — increasing the reliability of the safety installation. When a shut-in occurs, only one high pressure exhaust takes place . . at the safety valve. Choice of source pressure for the control line is optional — pressure is usually taken from the separator or furnished by bottled gas.

The system, in simplified form, monitors pressure changes through the Type P Otis Hi-Lo Auto-Reset Pilot. Pressure fluctuations beyond the preset limitation of the Type P Pilot cause the pressure on the control line to exhaust. Upon exhaust of the control line pressure, the pressure behind the piston of the Type N Otis Actuator Pilot is removed, allowing the pilot to exhaust a pressure chamber in the safety valve. This action serves to create a pressure differential in the safety valve and permits the line pressure to close the valve.

Installation Schematic of Typical GNP System



Operating Design Principle of Type GNP System



Illustrated as an example of a Type N and P Safety System is the Otis Type G Valve combined with the Type N and P Pilots. This combination of Otis equipment constitutes a safety system suitable for sensing pressure changes from a wide range of remote points. Although the Type G Otis Surface Safety Valve is used for illustration, the pilots may be used with other Otis Surface Safety Valves.

The Type P Pilot serves to monitor pressure fluctuations (within predetermined limits) in the flow line and/or other lines. Pressure variations, either too high or too low, cause the exhaust valve in the Type P Pilot to unseat and release the constant pressure on the connecting low pressure control line. When pressure is released from the control line, the low pressure on top of the piston in the Type N Pilot (Chamber A) is released and the piston moves back, allowing a ball to seat in the bypass of the Type G Valve. With the bypass sealed, pressure from Chamber B in the safety valve is exhausted through the pilot, creating a pressure differential across the ball and flow line pressure may then rotate the ball to the closed position. The entire system may be reopened merely by turning the resetting handle on the Type N Otis Pilot since the Type P Otis Pilot is designed to reopen automatically when pressures return to normal.

Single Point, One Step Reopening

The entire Type N and P Otis Pilot System is designed to be placed back in service after a shut-in by resetting the Type N Otis Pilot on the safety valve. The operation of the system is controlled from this one point . . there are no complicated procedures or detailed resetting instructions to follow. Merely turn the resetting handle on the pilot in as far as it will go and then back it out. The Type N Pilot also may be used to lock a safety valve installation out-of-service with the safety valve in the open position.

Design Principles of The Type N and P Otis Pilots

The adaptability of the Type N and P Low Pressure Pilot System comes from the flexible design principles incorporated into the two pilots . . Type N Otis Actuator Pilot and Type P Otis Hi-Lo Auto-Reset Pilot. As the name implies, the Type N is an actuator pilot for use on Otis Surface Safety Valves. The pilot does not monitor pressure changes, but acts only as a means for closing and opening the safety valve.

Well pressure is exposed to only a small portion of the pilot's valve plunger area. The internal springs, piston and other working parts of the pilot are normally never exposed to well fluids.

The standard Type N Pilot requires manual resetting. It may be modified for automatic resetting. The Type N Pilot is regularly supplied in a 150:1 operating ratio and installation records show a minimum of maintenance.

Type P Otis Hi-Lo Auto-Reset Pilot is a combination high and low pressure sensing device (0 to 10,000 p.s.i. range). It may be installed at any point in a surface safety valve system where protection is desired. The Type P Pilot does not require manual resetting after a shut-in but is designed to reset itself when the pressure it is monitoring moves back into the range of its settings.

A small pin at the rear of the pilot indicates whether the pilot is set and "in-service" or whether it has operated. Pressure from the monitored source enters in only a small portion of the ½" threaded male connection. Fluids that could corrode or damage the internal working assembly do not enter the main body area of the pilot.

For more details on the construction and operation of the pilot, see illustrations above.

Safety Equipment Recommendations

The Type N and P Otis Pilots are excellent examples of Otis' leadership in safety equipment. Experienced and trained Otis Safety Equipment Specialists have the combined knowledge of the company's more than 20 years experience to draw on when making installation recommendations. Whatever your safety equipment requirements, call the Otis office nearest you or write Otis, Dept. E-4, P. O. Box 35206, Dallas 35, Texas. You'll find Otis Safety Valve Specialists ready to help you . . anxious to serve you . . with the widest variety of production equipment and services available today.

OTIS
Engineering OTIS Corporation
General Offices:
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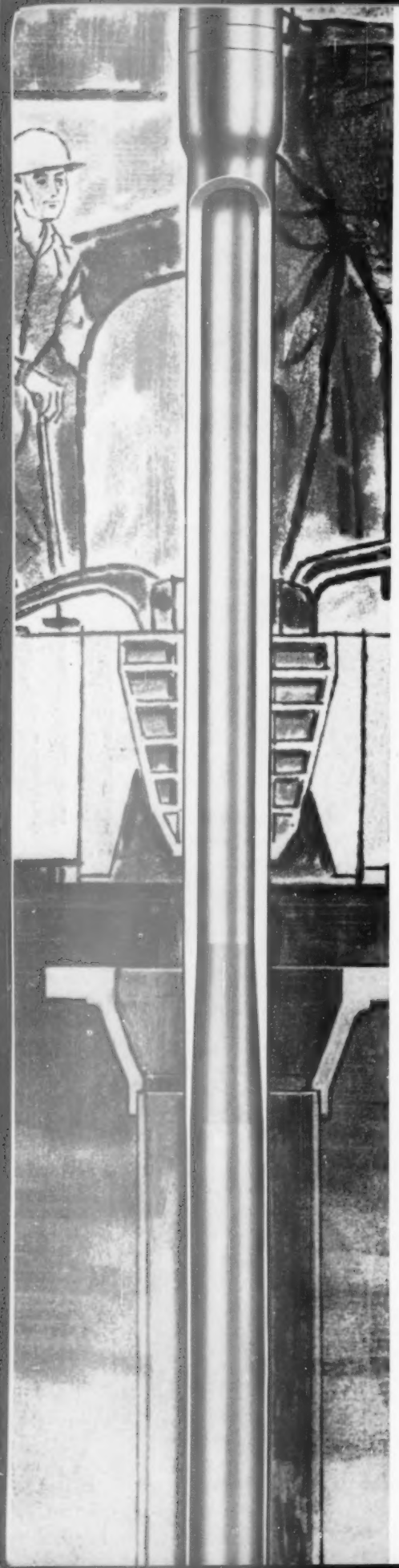


PITTSBURGH STEEL REPORTS ON...

DUAL WEIGHT DRILL PIPE

SUCCESS IN FIELD TEST

In West Texas, South Louisiana, Oklahoma and out on the West Coast, Pittsburgh Steel Company's new Dual Weight Drill Pipe is proving itself the way drillers best understand—by performance under actual field conditions.

Dual Weight is a completely new type of drill pipe developed and produced exclusively by the manufacturer of "Pittsburgh Seamless."

It provides drillers an integral combination of strength and light weight never before available in popular API grades and sizes of drill pipe.

Drilled footage on four strings of Dual Weight now stands at better than 100,000 feet—every inch of it under normal rotary drilling practices.

Results? Excellent—better than expected in some cases.

Field tests are continuing. Additional strings are being placed in service on drilling operations specifically selected to prove out Dual Weight's advantages and performance under the widest possible range of drilling conditions.

But, so far, here's what experience shows Dual Weight does:

- Cuts drill string weight.
- Increases rig depth capacity.
- Increases slip area strength up to 20 percent.
- Boosts hydraulic performance.
- Effects lower maintenance costs and longer service life on rig equipment.
- Cuts transportation costs.
- Increases drilling rates and speeds up round-trips.

• **What is Dual Weight?**—First of all, it's one of the most important developments in rotary drilling in many years. It's an entirely different type of drill pipe design—although it looks the same as other drill pipe. The difference is in the ID.

Look at the cutaway sketch at the left of this page. It shows Dual Weight's design features.

Notice the box end. Below the tool joint and upset, it has at least four feet (but not more than six feet) of heavy wall steel in the critical slip area. Then, a gradual, uniform internal taper makes transition to a light wall body that extends the remainder of the joint's length.

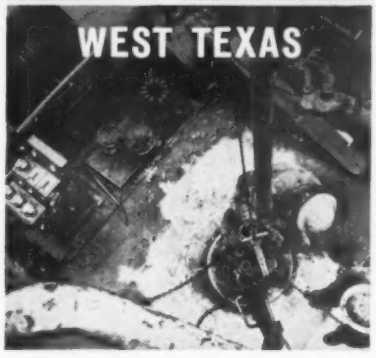
Some drillers refer to the heavy wall at the box end as a "long upset"—a good description, but inaccurate. The heavy wall is produced

by a patented process that bears no resemblance to upsetting.

Drillers can benefit two ways with Dual Weight.

If it's a lower hook load they want, then thin wall Dual Weight meets the need. It combines the strength of standard pipe in the slip area, and the weight saving of lighter weight pipe in the body.

Or, if extra strength and safety—rather than lower weight—are required, Dual Weight again is the answer. In this version, it has a standard wall body and an extra heavy box end with a safety factor near or equal to the safety of the body.



• **Strength?**—Either way, Dual Weight has it—in the slip area where it's needed to resist the notching, crushing, crimping, stretching and bending forces it is subjected to.

Light weight? Its thinner wall body eliminates pounds per foot over 85 percent of the length of a 30-foot joint.

For example, 4½-inch Dual Weight with a .337/.254-inch wall weighs 16.60 lb./ft. for 15 percent of its length (the box end) and 13.25 lb./ft. for 85 percent of its length (the body).

And don't overlook hydraulic performance. The larger ID resulting from Dual Weight's thinner body wall lets pumps push more mud at lower pressures. There's more energy applied at the bit. Penetration rates are higher and returns are better.

But here's a sample of how drillers themselves benefit from Dual Weight.

A Large Independent Oil & Gas Drilling Corporation—drilling shallow wells in West Texas with 6,000 feet of 4-inch (.330/.254-inch wall) Grade E Dual Weight.

A Drilling Superintendent—"I believe Dual Weight is the only thing for a little rig. Its lighter weight means less wear and tear on the rig and equipment. And when you move as often as we do, there's quite a saving on trucking charges. Any time we can get away from handling weight, we're better off."

A Veteran Tool Pusher—"We save trip time because we can come out of the hole faster. With less weight we get more rpm's. We save fuel, too, because our engine isn't working as hard."

• A major oil company, drilling deep wells in Louisiana with 15,000 feet of 4½-inch, (.337/.271-inch wall) Grade E and P-95 Dual Weight.

A company drilling engineer said: "We're looking for higher velocities and larger volumes of fluid at equal pump pressures from Dual Weight. We know we're getting better hydraulics—moving more fluid.

"In deep drilling with high mud weights, you get better penetration with increased bit hydraulic horsepower. We calculate we're getting a 25 percent increase in BHP."

Interested in more detailed information? Write for literature, or contact a Pittsburgh Steel district sales office or one of the independent distributors listed below.

Distributor Home Offices

Atlas Bradford Company
Houston, Texas

Bennett Supply Company
Midland, Texas

Buckeye Supply Company
Zanesville, Ohio

C. W. Cotton Supply Company
Tulsa 5, Oklahoma

Dunwoody Pipe & Supply Co.
Houston 2, Texas

Franklin Supply Company
Denver 22, Colorado

Houston Oil Field Material Co.
Houston, Texas

Industrial Supply Company
Wichita Falls, Texas

Iverson Supply Company
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Lion Supply Company, Ltd.
Calgary, Alberta, Canada

Longhorn Supply Co., Inc.
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Lucey Export Corporation
New York 7, New York

Lucey Products Corporation
Tulsa 19, Oklahoma

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Midland Supply Company
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Oil Equipment, Ltd.
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The Producers Supply & Tool Co.
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Southwest Supply Company
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Superior Iron Works & Supply Co.
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Steel

Cleanup Acid is the lowest-cost way of removing mud filter cake . . . increasing well productivity. It loosens and disperses filter cake solids so they can be removed from the well . . . increases productivity of formations that have been invaded by drilling mud . . . helps break emulsions and water blocks. Ideal, too, as a spearhead to increase the effectiveness of fracturing and acidizing treatments . . . or to ensure a better bond in casing or squeeze-cementing operations. And BJ Service Cleanup Acid costs *far less* than dissolving-type chemical solvents. Available in 5% solutions for sandstones or other HC1-insoluble formations . . . or in 15% solutions for HC1-soluble formations like limestones and dolomites—and *only* from BJ Service.

For complete details, call your local BJ Service field station today.

Leadership in Chemical Services Since 1932

Another outstanding example of field-proven developments from BJ Service Laboratories is J-Type Acid. J-Type is inhibited hydrochloric acid with surfactants to lower surface and interfacial tension and prevent formation of emulsion and water blocks. Used in carbonate reservoirs, it increases productivity by enlarging flow channels and leaving them free of emulsions. It has the additional advantages of faster and more complete clean-up, which reduces swabbing time. And J-Type Acid is "tailored" to individual jobs for *best* results.

BJ SERVICE, INC.

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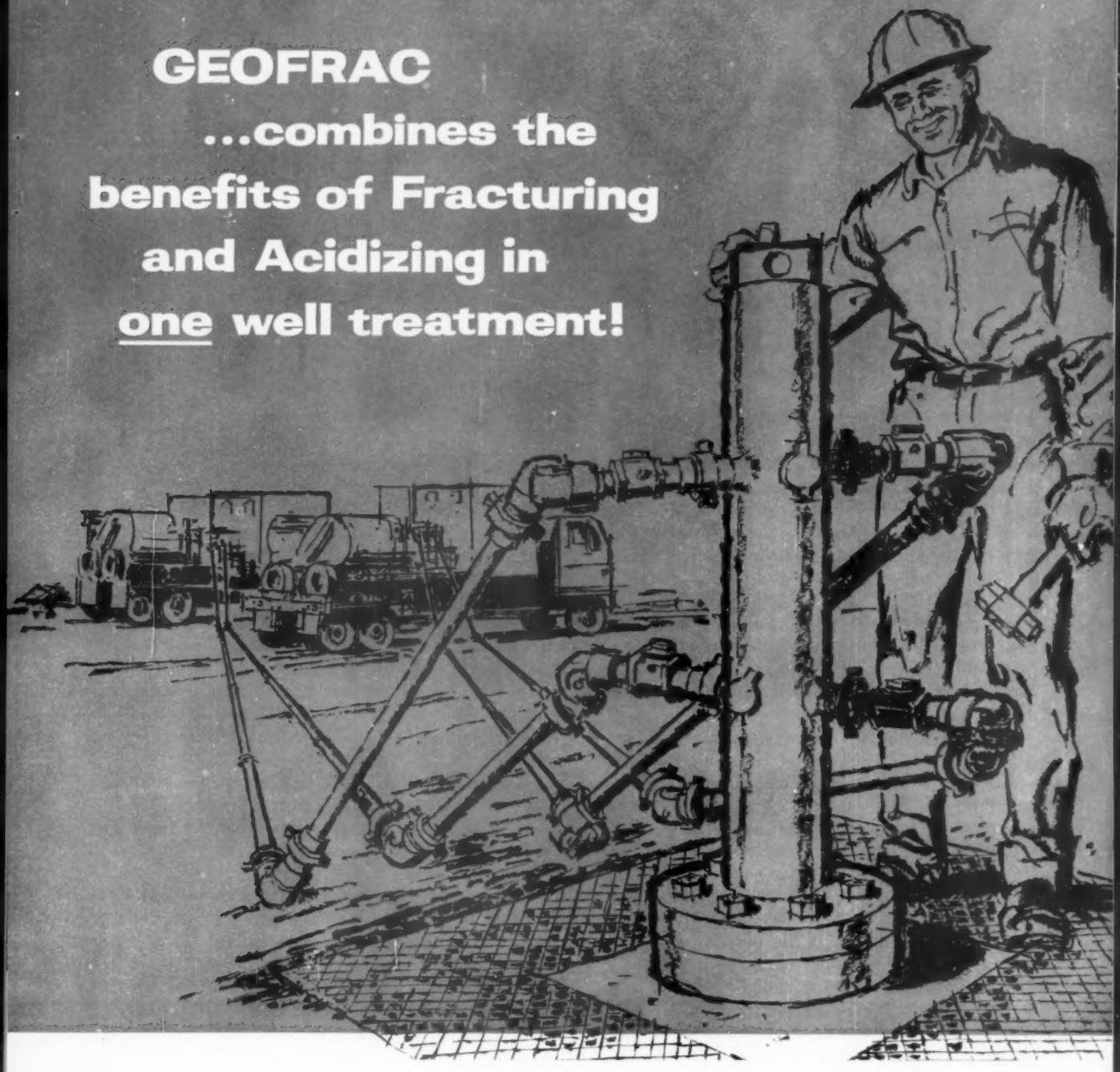
BJ B-W SERVICE

GEOFRAC

...combines the benefits of Fracturing and Acidizing in one well treatment!



Fracture and acidize in *one* operation with this superior BJ Service treating fluid. An acid in oil emulsion, Geofrac is a dual-purpose, sand-carrying fluid that has proven especially effective in limestones, dolomites and conglomerates, or other formations where carbonate dissolving action is desired. After the fracturing phase, with pumps shut down, Geofrac *continues* to work chemically within the pay. Its low fluid loss, high viscosity and temperature stability provide deep formation penetration—with no external gel breakers required. Selective, too. Since oil is the external phase, Geofrac penetrates oil-bearing formations more readily than water-bearing ones. Geofrac is available in both 5% and 15% inhibited acid strengths—and *only* from BJ Service.

For complete details, call your local BJ Service field station today.

Commander Pumping Unit

Designed and built by BJ Service, this superior all-purpose unit pumps the highest fluid rates in the field (up to 45 BPM)...also handles high-pressure jobs with ease. Commander features include two triplex ram pumps...engines with a high horsepower/weight ratio...automatic exhaust cooling...smooth performance at all speeds and pressures.

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Steel Patch Simplifies Casing Repairs

A new downhole casing repair technique, employing a stressed steel liner, has been developed by Pan American Petroleum Corp. In addition to sealing holes and splits, the new technique may also be effective in repairing parted casing in place.

Officially titled "Stressed Steel Liner for Casing Repair," the method is called simply the steel casing patch by its inventors, Pan Am research engineers who several years ago pioneered the fiberglass plastic downhole casing patch.

Extremely simple and easy to install, the steel patch remedy promises to be much faster and less expensive than conventional casing repair methods. Several field tests have been conducted by Pan American. In one, a casing leak at 1700 ft was repaired and tested in 5½ hr. In another, the tool was made up, patch set at 2000 ft, the repair tested and cleaning up was in process in 3½ hr.

A major advantage of the procedure is that well operations may be resumed as soon as testing is completed. Additional liners may be placed above or below earlier repairs.

Because of its low cost and simplicity, and the reduction of rig time and down time on the well, Pan Am engineers believe the steel patch method may ultimately replace conventional methods of repairing most sub-surface casing damage. With proration and secondary recovery extending the useful life of wells for many years, simple and inexpensive methods for repairing casing leaks should be in increasing demand.

Basically, the process involves two items: a glass fabric-wrapped section of ⅛-in. thick steel tubing coated with unset plastic and long enough to span the repair area, and a placement tool. The tubing, or liner, has an outside diameter slightly greater than the inside diameter of the casing to be repaired. By a special corrugating technique, the liner's effective diameter is reduced to permit running it inside the casing. The liner and placement tool are lowered on tubing and centered over the damaged area. By hydraulic pressure a die is pulled through the liner to expand it. This operation locks the liner under compressive stress firmly in place. Upon setting, the plastic and the glass form a permanent, high-strength seal between the liner and the casing.

The result is a section of pipe approaching, and in some cases exceeding, the original strength of new casing, in terms of bursting, collapse and tensile strength.

Internal diameter of the casing is not substantially reduced after repair. This reduction is only about double the thickness of the liner. Nor is there interference with any subsequent well operation, including drilling.

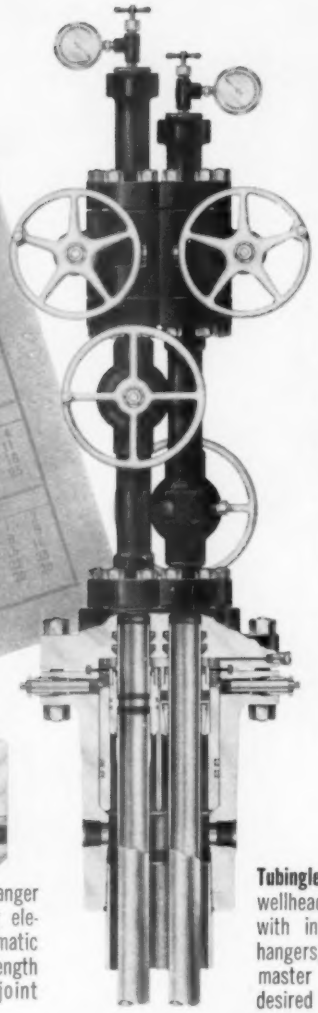
Pan Am has licensed the steel casing patch to three service firms. They are Davis-Kemp Tool Company, Inc. of Kilgore, Tex.; Halliburton Co. of Duncan, Okla.; and Houston Oil Field Material Co. of Houston.

Development of the technique involved designing and fabricating both the liner and the placement tool. Since no steel mill in the country was equipped to process the steel tubing to specifications, Pan Am engineers designed and built the prototype equipment. The designs were turned over to a fabricating firm and arrangements made for the fabricator to furnish the liners to the licensed service companies.

The stressed steel liner was developed specifically to repair damaged casing in old wells and this will undoubtedly be its greatest application. Pan American estimates that the treatment may be applied over the next few years to many of its wells throughout its operations.

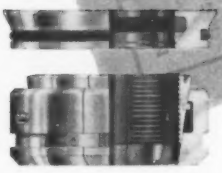
However, the technique may also find applications in drilling and completing new wells. ■

1961 Brought you these NEW O·C·T products

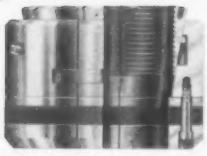


Again this year your needs for new types of wellhead equipment, to use with improved completion techniques, have kept us busy.

Here are the new designs introduced by O.C.T. during 1961.

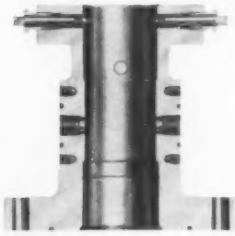


C-21 Casing Hanger — The C-21 consists of slips, slip bowl, and a floating seal ring that provides positive annulus packoff.



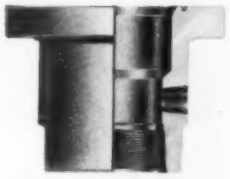
C-22 Casing Hanger — This hanger features a single-unit sealing element, slip bowl and slips; automatic seal; and load-carrying strength greater than the pipe's joint strength.

Tubingless Completion Wellheads — These wellheads give you maximum flexibility, with interchangeable slip and threaded hangers, a variety of casing heads, and master bushings to allow assembling any desired single or multiple completion.



T-C Multi-Head — This is a versatile tubing or casing head that accepts 13 different threaded and slip-type hangers for single, dual, or triple completions.

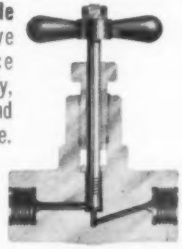
Independent Wellheads — These forged steel, low-pressure casing and tubing heads feature low cost and maximum parts interchangeability.



C-22 Casing Head — A straight-bore casing head designed to support maximum loads and to accept any of three interchangeable hangers.

Type M Tubing Heads — These macaroni tubing heads are designed for hanging 1½-inch and smaller inner tubing strings, especially for tubingless completions. They can be supplied with either flanged or threaded connections.

15,000 psi Needle Valve — This valve has a one-piece forged steel body, Teflon packing, and stainless-steel needle.



Heater Choke — O·C·T's heater choke is designed to give you extra nose length in the heater fluid; acme-thread unions speed installation and removal; many parts are interchangeable with other O·C·T chokes.

O·C·T

OIL CENTER TOOL CO.

SUBSIDIARY OF FMC CORPORATION

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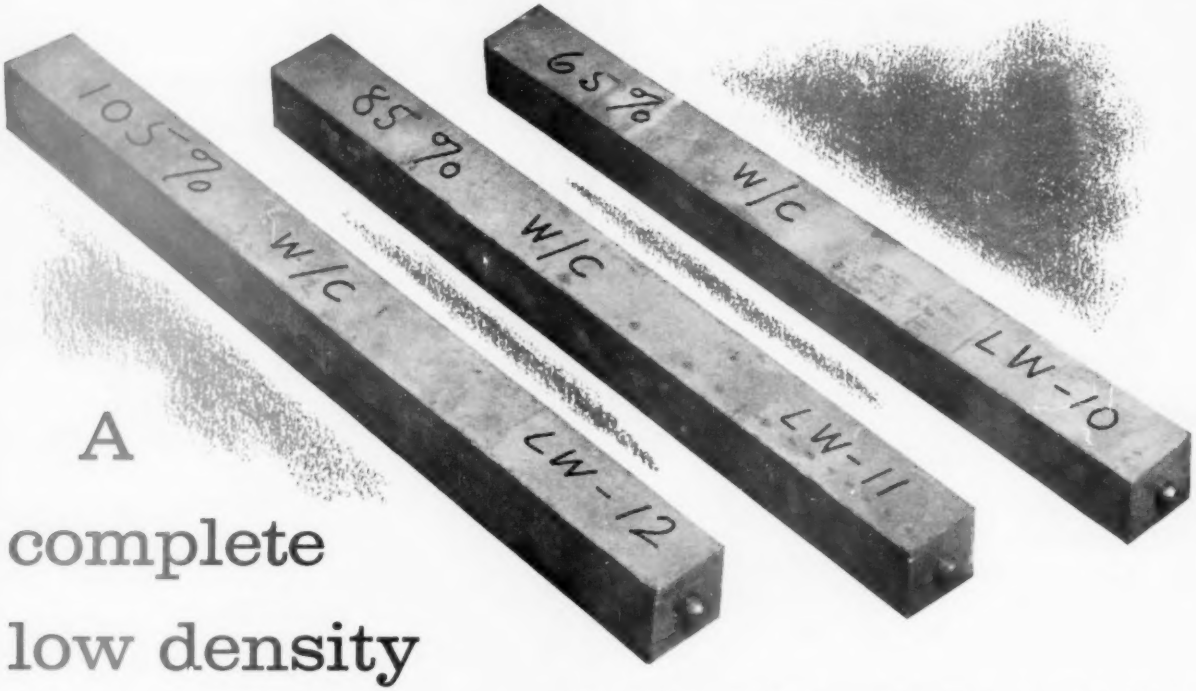
where progress is a daily practice

Trinity LITE-WATE



A complete low density cement that is

SULPHATE RESISTANT

Shown above are three unretouched photos of test bars produced from TRINITY LITE-WATE neat slurry that were immersed in a 5% sodium sulfate–5% sodium chloride solution for a period of more than one year. These bars are completely sound and show no expansion.

In the range of lightweight cement slurries, TRINITY LITE-WATE produces a slurry which is:

1. Sulfate resistant for lasting casing protection.
2. Remains impervious to migrating fluids.
3. Light enough to circulate.
4. Strong enough for any casing seat.
5. Strong enough to permit hydraulic fracturing.
6. Easy to mix, easy to pump.

For TRINITY LITE-WATE cement call your service company.

For complete Laboratory Data call your local Trinity Representative or write Dallas Office, P. O. Box 2698 or phone RIverside 2-8111.

75 lb. Dry Volume per cubic foot

TRINITY

PORTLAND CEMENT DIVISION

GENERAL PORTLAND CEMENT COMPANY

DALLAS·FT.WORTH·HOUSTON

WHY IT PAYS TO BUY WIRE ROPE MADE BY OIL COUNTRY SPECIALISTS

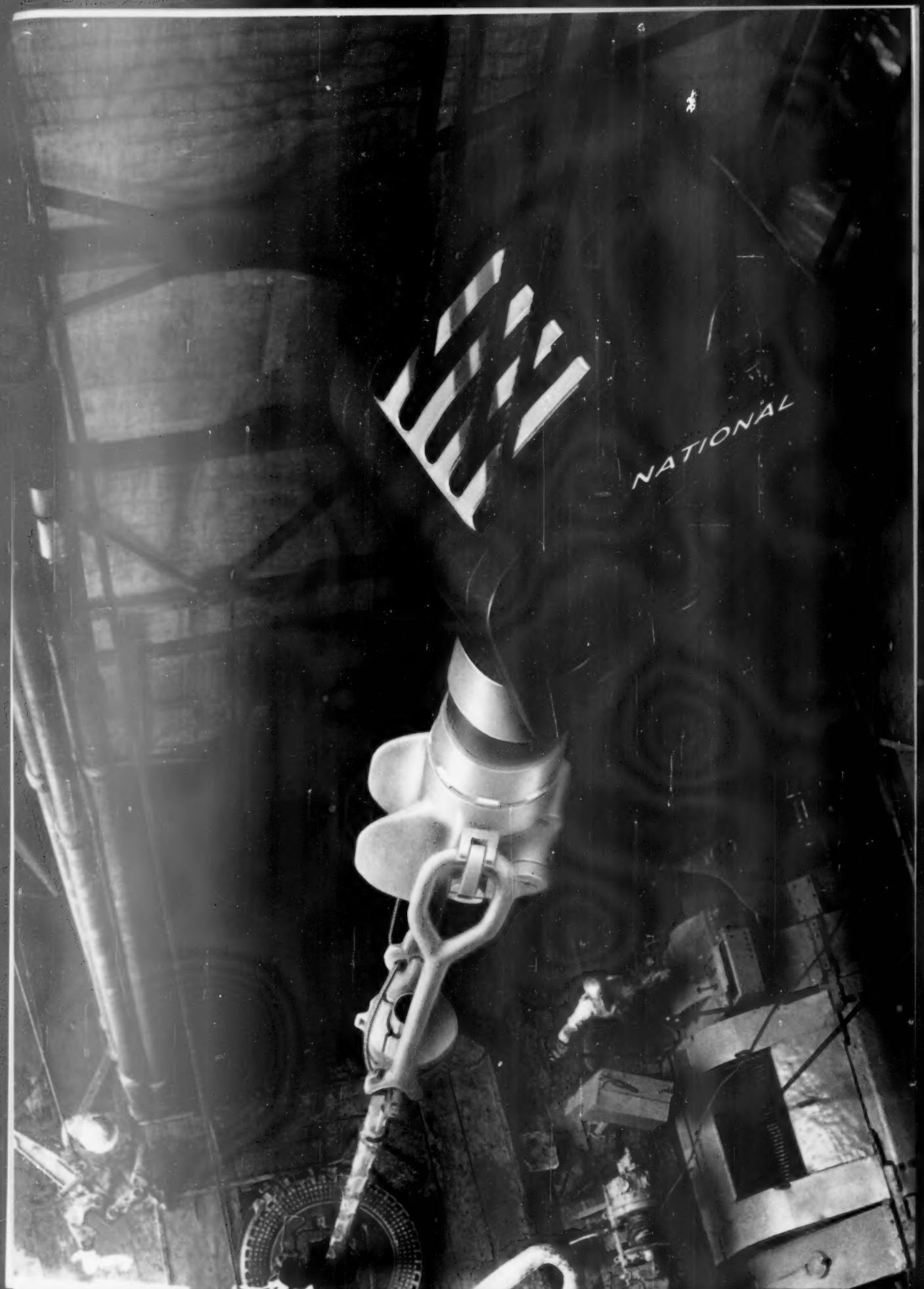
You get extra ton miles of service with Union wire rope products . . . because they are designed, tested and produced by specialists in oil country service. Union wire rope laboratories, foremost in this industry, conduct exhaustive field studies to improve performance, safety and service life. Union products are job-proved on the world's deepest wells under toughest operating conditions.

Your National Supply store carries complete stocks of Union wire rope products, including *Tuffy* rotary lines, sand lines, cut rope and slings.

These "ready to roll" stocks are immediately available and can be delivered with the other oil country supplies you buy from National Supply.

This combination of Union wire rope *quality* and National Supply *service* gives you the best buy in the oil country. You get prompt, immediate delivery by an oil country supplier who knows you and knows your problems.

See next pages for information on new National Type G Hook Blocks


NATIONAL

NATIONAL SUPPLY ANNOUNCES A NEW STREAMLINED TYPE G HOOK BLOCK

New National Type G hook blocks are the culmination of years of design development and testing in field applications. They are completely streamlined for safety and efficiency. The new hook blocks are now offered in four sizes, with ratings from 100 tons to 500 tons. Here are some of their outstanding features:

FULLY UNIVERSAL CONNECTION between hook and block. A crosshead is provided with integral trunnions extending through and supported by the side plates. Hook and block assemblies are quickly disconnected for shipment by pulling the crosshead pin.

BUILT-IN HYDRAULIC SNUBBER prevents bouncing of drill pipe stands when spinning out and consequent costly damage to tool joint threads.

CONSTANT TORQUE POSITIONER. This device, which is standard equipment, keeps the drill pipe elevator from rotating out of position when it is going up empty. Derrick man can latch the elevator easily and is less likely to miss stands.

IMPROVED TONGUE CONSTRUCTION. Each tongue has a smooth, uninterrupted bail contacting surface which is contoured to properly support and protect the swivel bail. Tongue of the hook block is automatically latched when the swivel is picked up and cannot be opened accidentally.

TAPERED ROLLER BEARING SHEAVES. Sheaves are independently mounted on double row, tapered roller bearings that reduce sheave friction to a minimum. Rope grooves are machined in accordance with A.P.I. recommendations and are flame hardened.

CONVENIENT ROTATION LOCK. Each hook block has a rotation lock that will either lock the body in any one of eight equally spaced positions or permit free rotation.

STREAMLINED DESIGN minimizes the possibility of the block's catching on finger boards or other mast or derrick projections. All screws, nuts and levers are recessed and securely locked in place for maximum safety.

These are just a few of the features of the new National Type G hook blocks. Get complete details by contacting your National Supply representative, or writing to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

NEW TYPE G HOOK BLOCKS

	330G100	435G175	540G250	545G350	650G500
Number of sheaves	3	4	5	5	6
Sheave O.D., in.	30	35	40	45	50
A.P.I. rating, tons	100	175	250	350	500

National is also currently offering a line of five separate H hooks with ratings similar to the new G hook blocks. The hooks have conventional bails which can be used with any traveling block having a regular lower clevis.

Type G Hook Blocks are made heavy so they will fall freely. Short design provides maximum crown block clearance.

Steel's Symbol of strength, long life, and economy

Steel

See next page for information on National Swivels

- **Uniflex Wash Pipe Packing Assemblies**
- **Quick-Seal Hose Connections**

TWO REASONS FOR SUPERIORITY OF NATIONAL SUPPLY SWIVELS

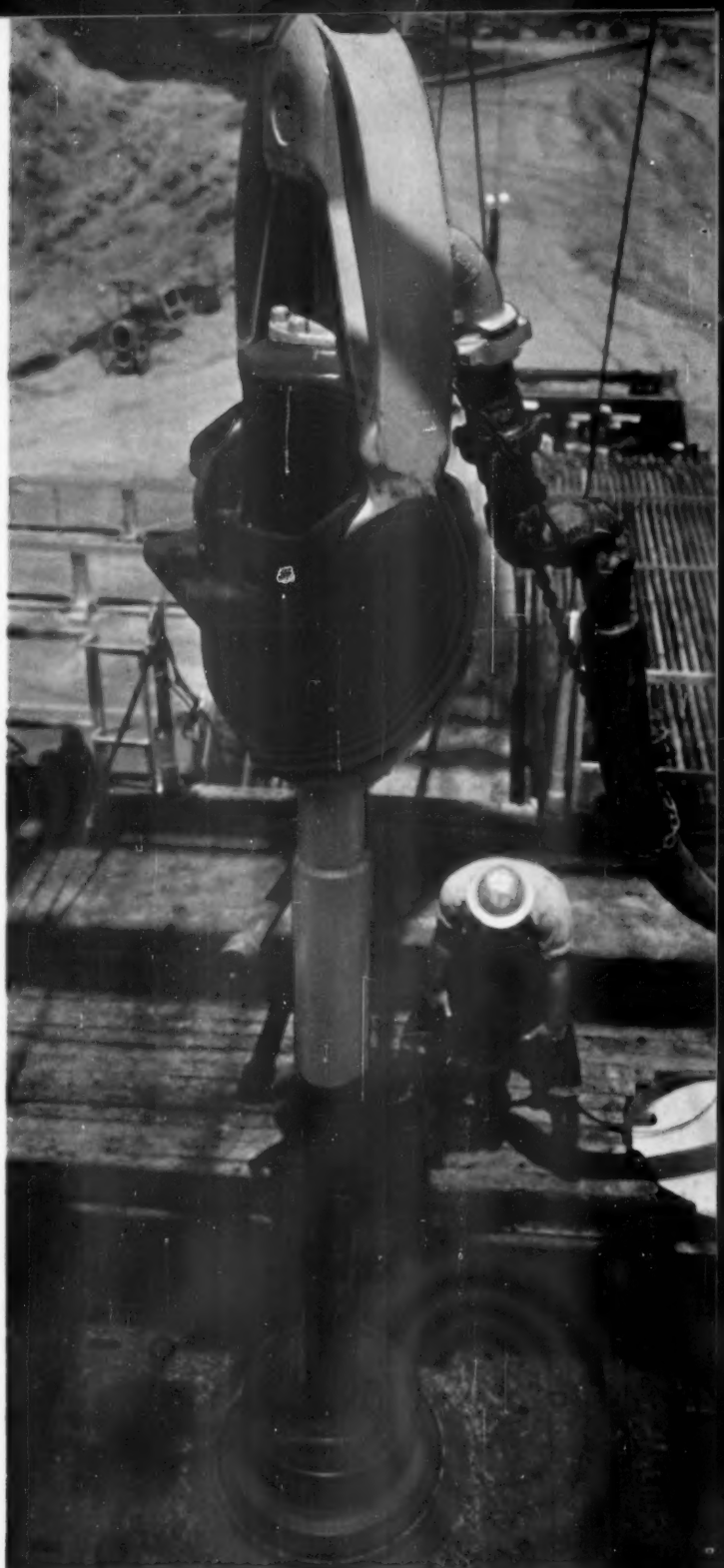
Field tested Uniflex wash pipe packing assembly of National Supply swivels incorporates a free-floating type wash pipe that provides an improved method of packing off the mud. Packing is unitized cartridge type. Light weight of the assembly and quick-breaking threads speed replacement. Assembly can be installed without removing gooseneck or hose connections.

Quick-Seal hose connection features large, quick-breaking threads and uniform sealing elements to withstand rugged use. Design eliminates one hose connection member. All parts are made of steel and plated to resist corrosion and thread galling.

The Uniflex wash pipe packing assembly and the Quick-Seal hose connection are outstanding features of seven National swivels having comparative dead load ratings from 82 to 500 tons — and depth ranges extending from 1,000 ft. to 24,000 ft. There is a superior quality National swivel to meet any drilling requirement. Let your National Supply representative give you details, or write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

National Supply also offers the new, small T-12 swivel, with an A.P.I. rating of 25 tons at 100 r.p.m. and a comparative dead load rating of 50 tons. It is used with small portable or trailer mounted rigs in exploratory, slim hole and shallow drilling, or on workover jobs.

Features are: • High strength-to-weight ratio • Low center of gravity • Precision line bored bail • Opposed Timken tapered roller bearings for true axial alignment.



Low center of gravity in streamlined National Supply swivels gives you greater stability in handling, easier and faster connection of sub to kelly.

ARMCO National Supply Division

XP-20/Spersene mud systems are so simple, yet they can do what other muds have tried to do for years

In spite of this simplicity, XP-20/Spersene muds are unusually stable under high temperatures and high pressures. They have outstanding filtration characteristics. They retard the natural swelling of solids. They have excellent tolerance for contaminants. XP-20/Spersene muds do what other muds have tried to do for years, and at much less cost.

Magcobar Complete DRILLING MUD SERVICE

DRESSER INDUSTRIES, INC.
OIL • GAS
CHEMICAL
ELECTRONIC
INDUSTRIAL

MAGNET COVE BARIUM CORPORATION / HOUSTON, TEXAS

The "OILWELL" string...

PRODUCTS
SERVICES
STORES

Why it's called the "cold sweat" period

It starts when the switch is thrown and the valve opened to give life to the pumping unit on the new well. It lasts until they see what "pumps up." The interval is "cold sweat" because no one can afford losing money on faulty equipment. One way to make sure you get the performance you pay for is to use "Oilwell" equipment and the services of your "Oilwell" field engineer. His job is to see that the proper planning goes into the installation from the start. He'll gladly supervise setting the unit up. And to make sure he's done his job right, he's usually on hand during the "cold sweat" period.

"Oilwell" engineers are no further away than your telephone. They're a big reason why you get much more than a piece of equipment when you buy from "Oilwell". If you need equipment, or if you simply need advice, the best place to call is "Oilwell".

For a longer run for your money switch to "Oilwell" Subsurface Pumps

"Oilwell" has been throwing money "down the hole" for years with one thing in mind: to beat torturous hole conditions where subsurface pumps *must* perform to turn a profit. Every dollar we've spent in subsurface pump research and design has paid off in longer life, less "pulling" and lower lifting costs.

There are no less than 7 different kinds of "Oilwell" subsurface pumps from which you can choose, each tailored for specific hole conditions. Standard wall and heavy wall rod pumps, sectional liner rod pumps, and tubing pumps are available in all API types, and every "Oilwell" pump features *Streamline Flow* design that lessens wear. Select from these famous performers to suit your requirements.

Di-Hard—has locked-liner construction and low coefficient of friction and is highly corrosion resistant.

Silverline—for medium depth wells where corrosion and abrasion pose no serious problems.

Hi-Brin—features the hardest one-piece barrel you can buy. Resists hydrogen sulphide corrosion.

Nitriline—a moderately priced hardened barrel for abrasive and mild corrosive wells.

Spun Metal—Barrels are cast liner type. For most wells containing medium CO_2 or medium H_2S corrosion with medium abrasion.

Krom-I-Dee—for combating sweet corrosive fluids and to resist abrasion in extremely sandy wells.

Three-Tube—chrome surfaced tubes and fluid seal minimize abrasive action of sand. Outstanding where there's floating sand.

For more information, write for a free copy of our 38-page booklet, **Selection and Application of Subsurface Pumps.** Or visit your nearest "Oilwell" store and talk with our Pump Specialists.

No white mice here

Believe it or not, it costs less to drill a foot of hole today than it did 100 years ago. Research and technology have turned that incredible trick by cutting drilling weeks to days, reducing costly fishing trips, doubling and tripling equipment life. Look a little beyond most of these remarkable developments and you'll find the name "Oilwell". It takes the finest research facilities to help win the battle for lower costs, the kind of facilities you'll find in "Oilwell's" laboratories and United States Steel's Research Center at Monroeville, Pa. In the picture, a USS basic researcher is probing the causes and cures of corrosion by analyzing the nature of thin oxide films on steel surfaces. There may be white mice somewhere else in the lab, but here the basic idea is to lead the way to longer-lasting equipment for corrosive wells.

USS, "Oilwell", DI-HARD, HI-BRIN, KROM-I-DEE, NITRILINE and SILVERLINE are registered trademarks.

Oil Well Supply
Division of
United States Steel

USS

Executive and Export Offices: Dallas Texas

New Tool Hunts Offshore Oregon Oil

A unique, gas-powered "gun" which fires sonic bullets is being used by Standard of California — Western Operations, Inc. to search for potential oil deposits off the Oregon coast.

The device, known as a gas exploder, is attached to the stern of the 100-ft exploration ship "Morning Star." It detonates an oxygen and butane mixture every 3 seconds to bounce a signal off the earth's crust thousands of feet below the coastal waters.

Sensitive microphones towed beneath the surface of the water pick up the signals and relay them to seismographic recording equipment on the ship, furnishing an accurate picture of the geological formations underneath. Data gathered are then interpreted by a team of Standard engineers who watch closely for any indications of strata which might contain petroleum deposits.

The search is conducted over an exact course, predetermined by the oil explorers, who keep in constant radio communication with guiding beam stations onshore.

An important side benefit of this new form of sonic prospecting is that it can be carried on in the midst of sports and commercial fishing without disturbing fisherman or fish. Although powerful enough to send a sound wave nearly a mile into the earth's crust, the exploder is almost inaudible a hundred feet away from the exploration vessel.

Working 12 hr a day or more, Standard's oil searchers will be cruising the Oregon Coast for several weeks in the hunt for a natural resource which, if found, could provide an important boost to the state's economy.

Only a few months ago, Oregon's House of Representatives authorized oil and gas leasing on the state's tide and submerged lands. The law was described at that time as "one of the soundest ever drafted."

Several companies have conducted exploratory programs in Oregon during the past few years without finding commercial quantities of oil and gas.

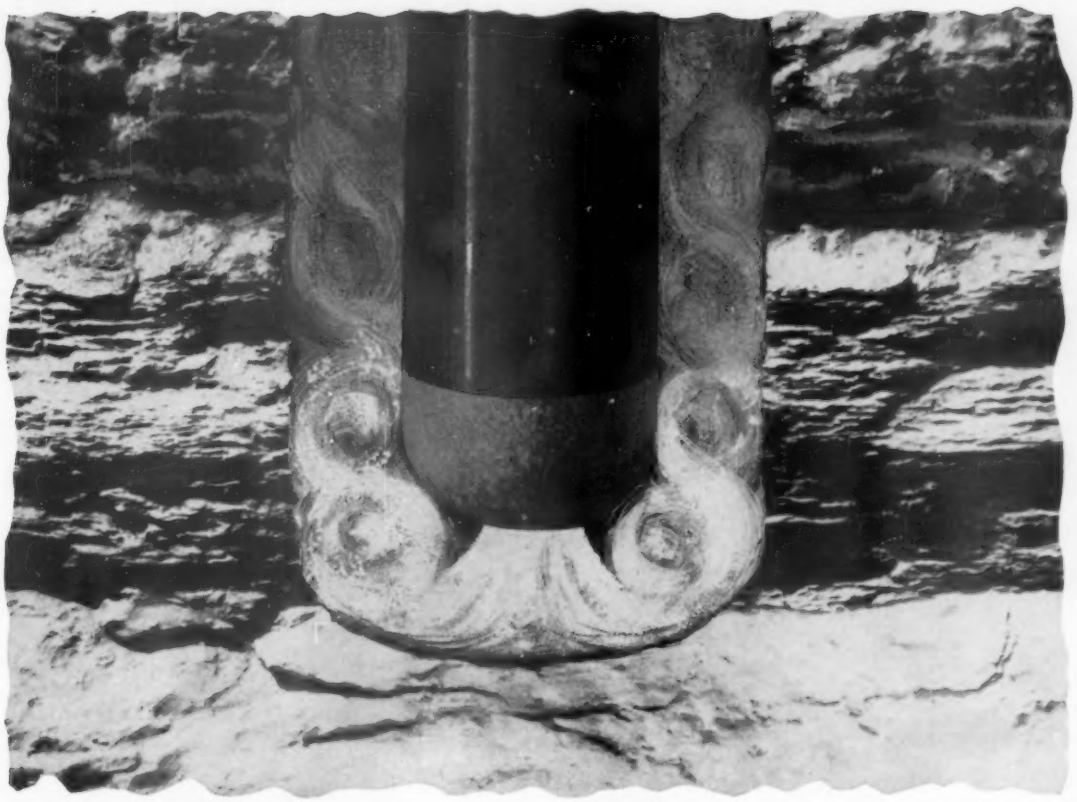
F. E. "Ed" Siever

H. G. "Hal" Bentson

Smith Tool Promotes Two Executives

F. E. "Ed" Siever, former Mid-Continent sales manager, has been appointed vice president—domestic sales (including Canada and Alaska) of Smith Tool Co., a division of Smith Industries, International, according to an announcement by Kenneth H. Swart, president of Smith Tool. Siever joined the company in 1955 as a regional sales manager, and for five years previous was a partner of Smith Bit Distributing Co. of West Texas. He will headquarter in Odessa, Texas. He assumes his new post following the resignation of Arthur S. Marshall.

H. G. "Hal" Bentson was made vice president-export and industrial sales of Smith Tool Co. after serving since 1955 as chief engineer-sales. Prior to 1955, he was associated for 17 years with Security Engineering Co. He is a registered professional engineer and a member of API and AIME.



SLURRY-FLO PLAN

AN EXCLUSIVE HALLIBURTON SERVICE PREPLANS OPTIMUM CEMENT FLOW RATE

SLURRY-FLO PLAN helps improve primary cementing by pinning down the most economical way to achieve a high displacement rate exceeding laminar flow in a cementing system. SLURRY-FLO PLAN also advises against attempting turbulence where well conditions make it impractical to achieve it.

Turbulent cement flow kicks mud up the annulus ahead of the cement slurry more efficiently than slower injection rates. Studies of jobs in areas where many primary cementing problems occur show that using one cementing truck has resulted in removing only 60% of the mud from the hole. Turbulent flow rates obtained by using the number of trucks determined by SLURRY-FLO PLAN have resulted in 95% mud cleanout ahead of the cement.

HERE'S WHAT IS COMPUTED FOR YOU IN A SLURRY-FLO PLAN

- The annular slurry velocity required to obtain turbulent flow.
- Calculation of pressures required to achieve preselected cementing compositions and displacement rates.
- Pressures to be anticipated under turbulent flow conditions.
- Estimated minimum horsepower required to put fluid into turbulence.

SLURRY-FLO PLAN can help you design more efficient cementing systems to give your wells the best possible pipe-to-formation cement bond.

See your Halliburton man for full details on this exclusive new service.

CEMENTING SERVICES

Halliburton
COMPANY · DUNCAN, OKLAHOMA

275 Service Centers . . .
just minutes away from your well

Lloyd Curry, Houston store pump repair man, running vacuum machine leak test on ball and seat

You can't see the biggest item that goes into a pump repaired at Wilson Supply . . . It's SERVICE!

The biggest single item that goes into a pump repaired at your Wilson store is *service*. As you would expect, the pump repair men at Wilson Supply have the proper testing equipment, complete spare parts inventories and know-how to repair your sub-surface pumps *properly* and *promptly*.

But when it comes to service, you can see a difference! Your Wilson pump man knows how important it is to get your pumping well back on production. He will work round-the-clock, weekends and holidays — if that is what it takes.

For fast field pump repair service, call your Wilson Supply man. You will receive the kind of service that saves you production dollars.

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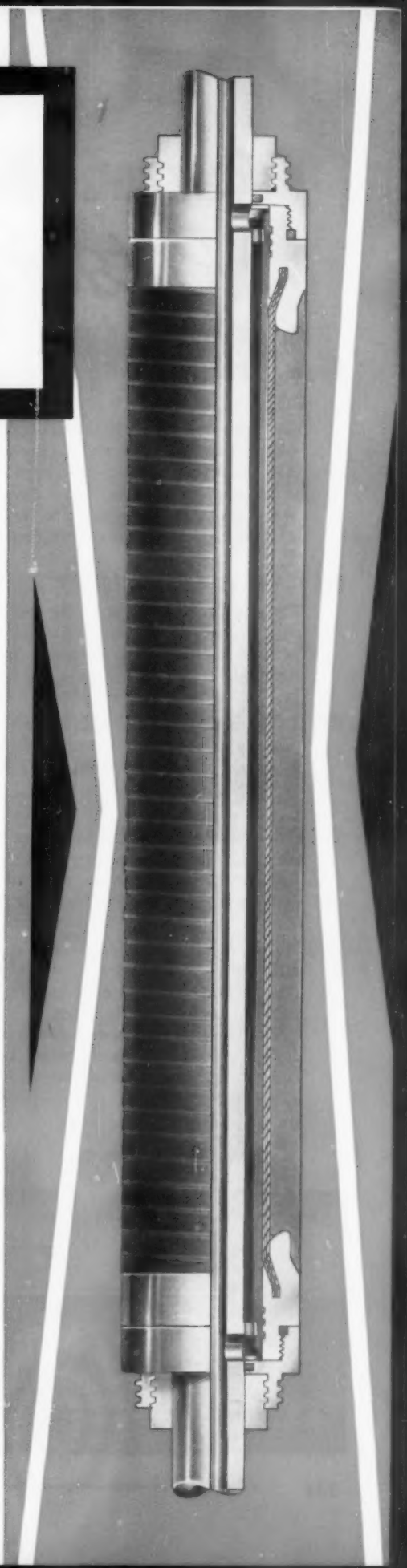
LYNES

INFLATABLE SEALING ELEMENT



A Basic Tool for Modern Oil Recovery

Sealing in open hole or in pipe with an inflatable element is a simple principle, yet the LYNES Inflatable Sealing Element and packer took ten years of extensive engineering development and testing before this principle became an effective tool for the oil industry.

Since 1950 LYNES Inflatable Sealing Elements have been tried and proven in thousands of wells and are recognized throughout the industry as The Inflatable Packer.

The LYNES Wildcat Straddle Tester using the inflatable sealing element has opened many fields to oil production that would otherwise have been lost by providing a low-cost method for treating and testing questionable open hole zones without setting casing. By the same token, money has been saved by proving holes dry without expensive completion costs.

The LYNES Production-Injection Packer featuring the inflatable element was made available to the oil industry as a sale tool in 1958 and has been proven as a safe and economical solution to many production or injection problems.

LYNES single and straddle element tools are used for treating and testing multiple zones in casing and/or open hole, for making formation fracture impressions, for locating thief zones or casing leaks and for many other uses. In addition LYNES inflatable elements are used on the LYNES INFLATA-TEST Units providing a safe, positive pressure test of tubing after it has been made up to lower into the well.

See how LYNES can help you in your drilling and production operations, call your LYNES representative soon.

LYNES, INC.

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LYNES
BRIGHT NAME IN THE OIL PATCH
Inflatable Sealing Element Packers

Guiberson's New *Rotating* J2 DRILLING HEAD

Now you can do well servicing and completion work better than ever with Guiberson's J2 Drilling Head that has a built-in, compact rotary table. Twenty-one new features have been built into this husky head. All designed for longer life..easier maintenance..faster, more profitable jobs for you.

USE IT FOR REVERSE OR CONVENTIONAL CIRCULATION. For your drilling or servicing work set-up the J2 head either way. Then circulation can be changed back-and-forth at will for faster, more economical cleanout.

USE IT FOR GAS OR AIR DRILLING. The new type wash pipe is designed for continuous drilling. An advantage you can use to complete jobs faster..more economically.

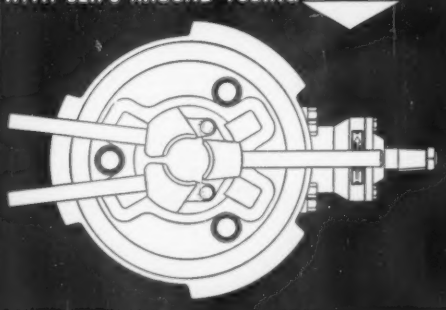
USE IT FOR SLIM-HOLE DRILLING. You'll like the unitized slips for one-man operation..more pipe holding strength..easier on your tubing. Plus the heat-treated kelly drive bushings for longer wear.

ADDITIONAL FEATURES. Heavy-duty spindle..retainer ring takes spindle load..wash pipe hardened *throughout*, not just case hardened..wash pipe packing replaceable in field..two lubricated dust seals protect bearings and gear..strong lifting eye hooks, cast integral with body..fast, easy rubber tightening with 3 studs..quick detaching top for easy rubber removal.

Better be Safe than Sorry — go Guiberson

TYPE J2 DRILLING HEAD WITH KELLY BUSHINGS IN PLACE

HEAD WITH SLIPS AROUND TUBING



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PRODUCTION, DRILLING AND WORKOVER SPECIALTIES, MOLDED RUBBER PRODUCTS

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Single action Colt owned by early Texas Ranger

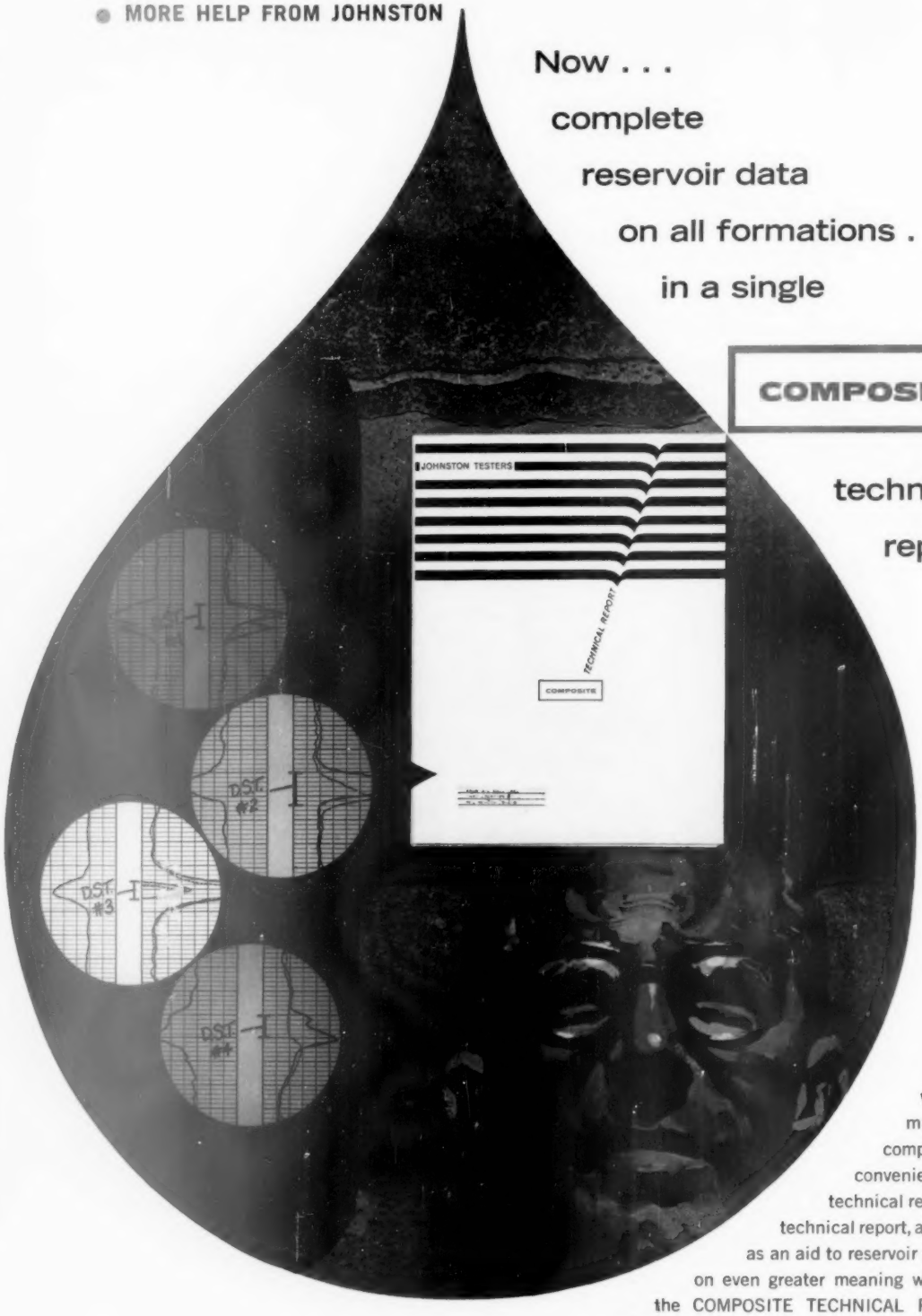
Maintenance often meant the difference . . .

RELIABLE SERVICE IS NO ACCIDENT ■ SCHLUMBERGER TAKES EVERY PRECAUTION TO MINIMIZE DOWN-TIME IN THE FIELD—FROM PRE-DEPARTURE CHECKS ON EVERY JOB TO 10,000 MILE MAJOR OVERHAULS—FROM MONTHLY CABLE MEASUREMENT AND INSPECTION TO MAINTENANCE AND MODERNIZATION OF ELECTRONIC TOOLS ■ RECORDS OVER THE YEARS PROVE SCHLUMBERGER'S THOROUGH AND NEVER-ENDING PREVENTIVE MAINTENANCE PROGRAM MEANS BETTER SERVICE AND A MINIMUM OF LOST RIG-TIME FOR YOU—THE OPERATOR.

SCHLUMBERGER LEADS IN PREVENTIVE MAINTENANCE

HOUSTON

● MORE HELP FROM JOHNSTON



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complete
reservoir data
on all formations . . .
in a single

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technical
report!

Now, data from wells requiring multiple tests are compiled in a single convenient, comprehensive technical report. The Johnston technical report, announced recently as an aid to reservoir engineering, takes on even greater meaning with the advent of the COMPOSITE TECHNICAL REPORT. Look to Johnston . . . the originator of testing . . . for continued improvements in reservoir data gathering.

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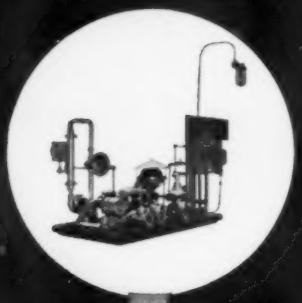

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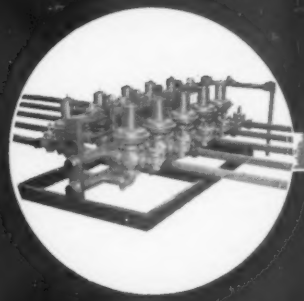
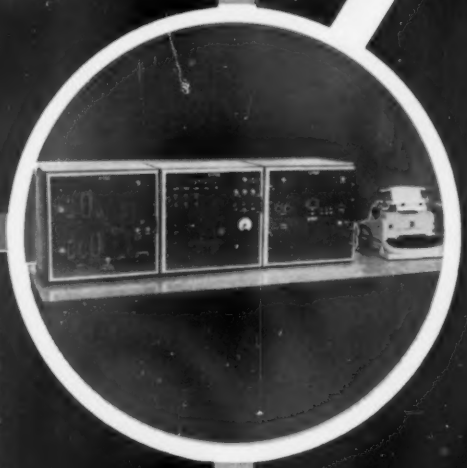
You can have it... step by step ...or complete in one leap!

Here are three good reasons for automating with BS&B...

- **ONE SOURCE FOR ALL EQUIPMENT.** Production and processing equipment, electro-pneumatic controls and valves are built and sold by one diversified manufacturer.
- **DESIGNED AND BUILT WITH EXPERIENCE.** Systems and components are designed and built by men who have pioneered oilfield automation.
- **RELIABLE SOURCE OF SUPPLY.** Over a long period of time BS&B has earned a reputation for reliable service to its customers and to the oil industry.





BS&B Automation Headquarters: Box 1714, Oklahoma City, Oklahoma

BSB **BLACK, SIVALLS & BRYSON**

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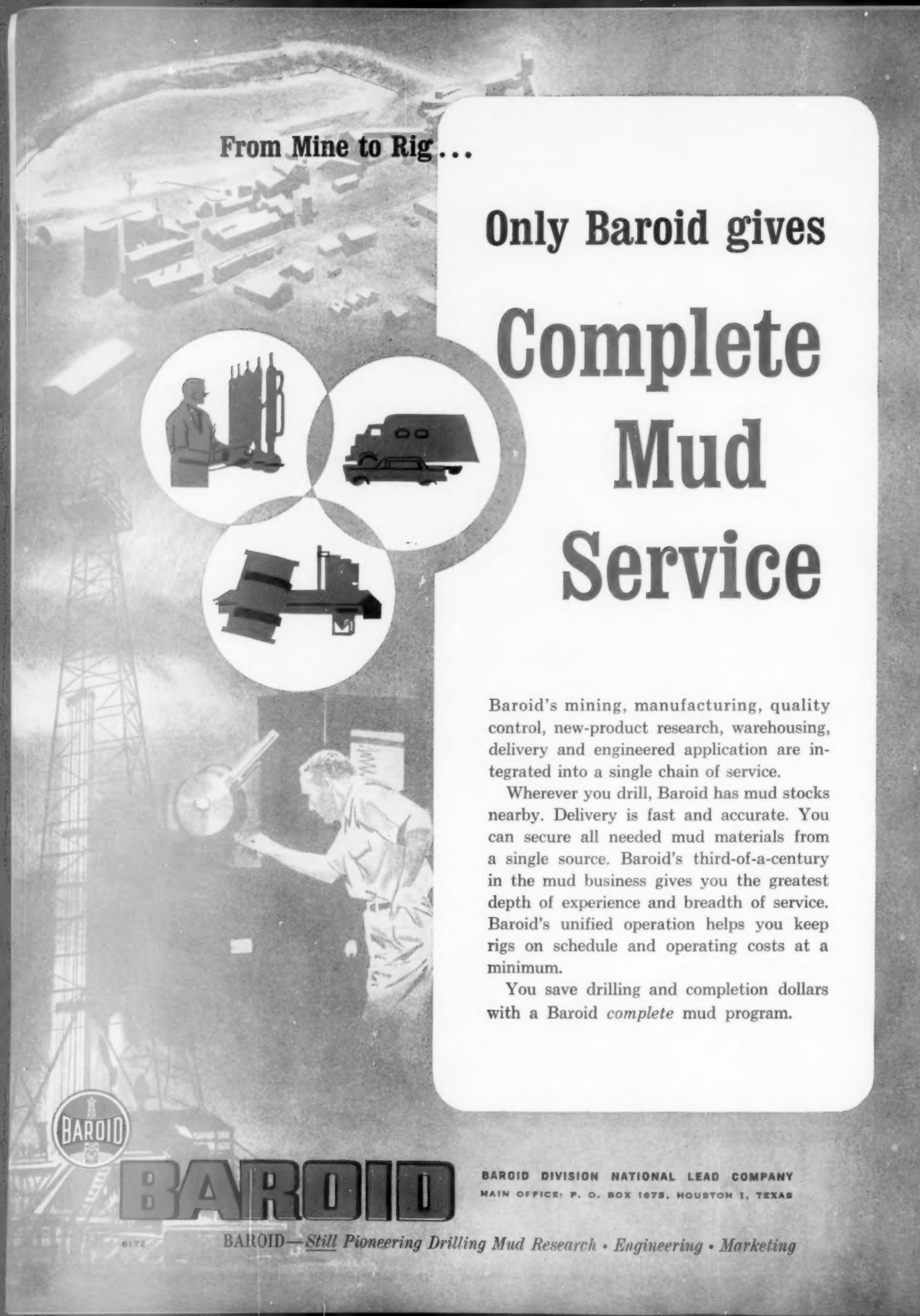

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Complete Mud Service

Baroid's mining, manufacturing, quality control, new-product research, warehousing, delivery and engineered application are integrated into a single chain of service.

Wherever you drill, Baroid has mud stocks nearby. Delivery is fast and accurate. You can secure all needed mud materials from a single source. Baroid's third-of-a-century in the mud business gives you the greatest depth of experience and breadth of service. Baroid's unified operation helps you keep rigs on schedule and operating costs at a minimum.

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BUSIEST VALVE IN THE OIL FIELD

UNIBOLT

ADJUSTABLE VALVE

This valve does so many jobs . . . so well . . . so economically. An Oklahoma waterflood Operator writes that it has practically eliminated valve failures on a manifold where conventional valves were being replaced every few months.

An Operator in Southeast Texas had a severe corrosion problem with carbon steel valves on gas-distillate wells. Replacements were being made every six to eight weeks. UNIBOLT Adjustable Valves with special analysis stainless steel stems and seats have been in continuous service on the same wells since 1946, and are still in excellent condition! Many Operators have standardized on UNIBOLT Adjustable Valves for practically all production services because they can be converted to either positive chokes or to automatic high/low valves by substituting interchangeable parts. Thus, inventories of these three items can be kept at a minimum.

UNIBOLT Adjustable Valves have numerous distinctive features that make them ideal for general oilfield service. For the complete story, call any UNIBOLT representative or write:

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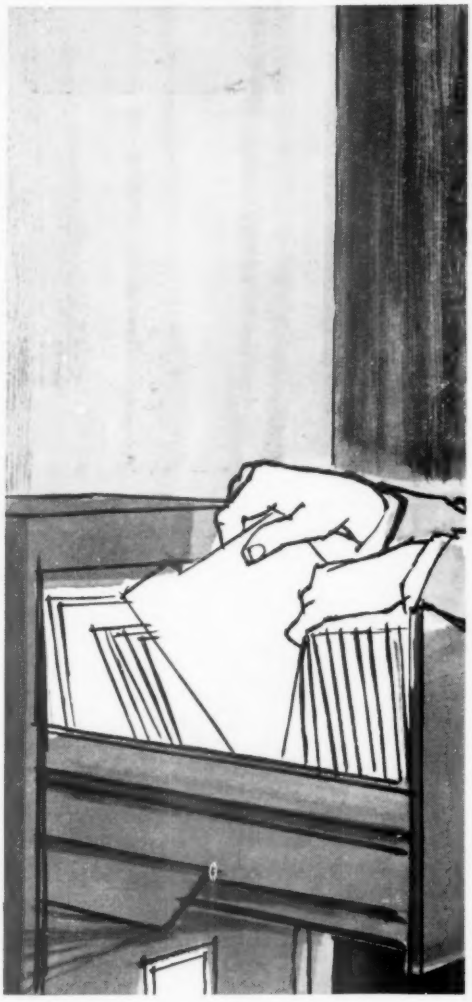
Today, electronic answers for your cut-off

1. **When is the right time** to cut the right length of rope? With Union's new electronic brain calculations you don't have to guess—you **know** exactly the maximum safe service to expect. It took 462 charts and more than 600,000 calculations, but oilfield wire rope cut-off procedures now are scientifically based. Union's Tuffy has figured it all out on the IBM "705" electronic brain.



2. **Union's staff of trained engineers** goes to work on your problem at once. All variables are considered — drum diameters, derrick heights, drill collar and pipe sizes, rope diameters, design

How would you like to use the same magic brain that it takes to get missiles and rockets off the launching pad to solve *your* Cut-Off Procedure problems on your next drilling job? Now you *can*—and Union Wire Rope brings you this million dollar service free. We have over 600,000 electronic calculations to make ton-mile charts—charts that tell you the proper length and time to cut rope for maximum safe service for any drilling operation anywhere in the world.

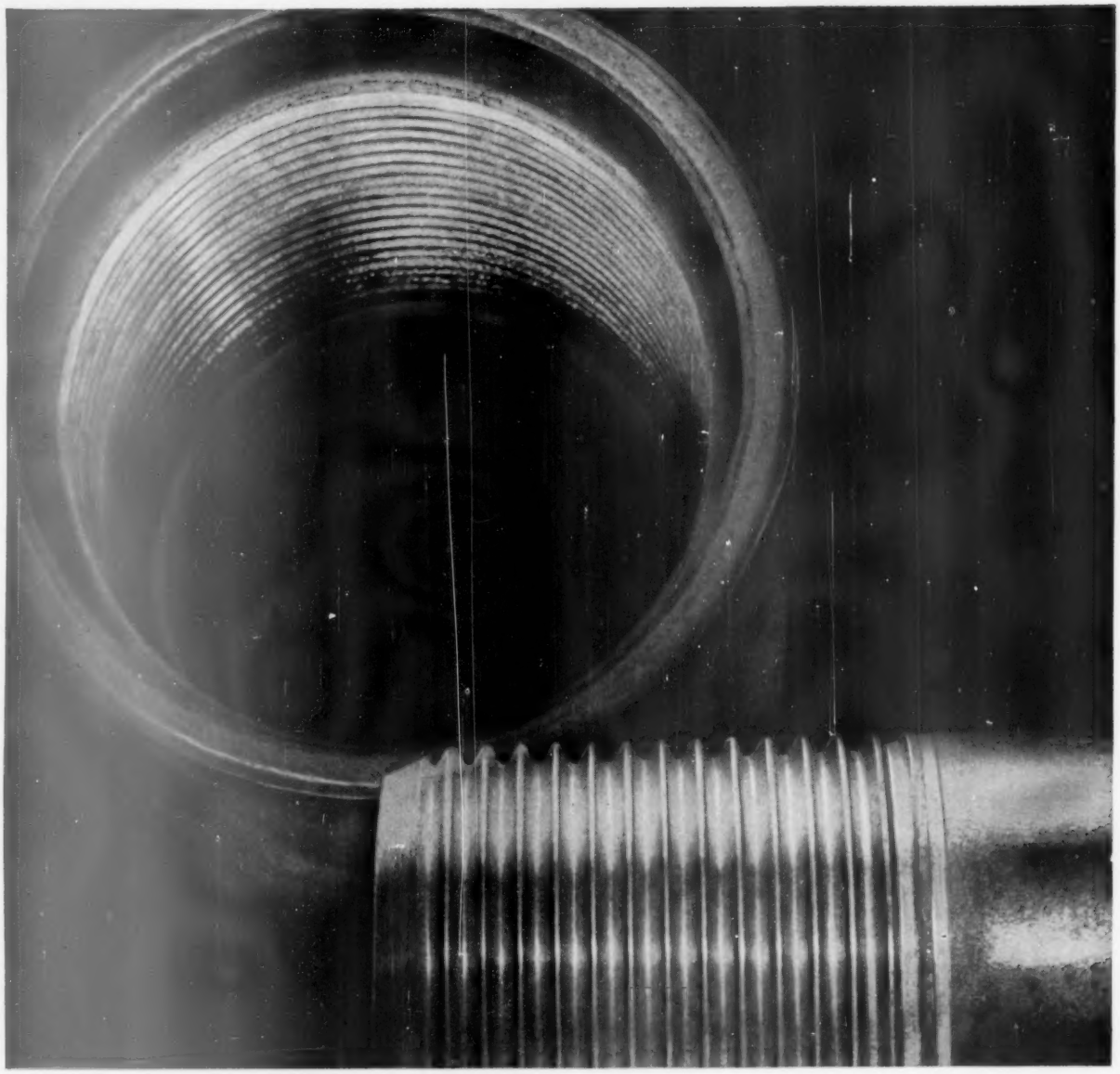
Try this new Electronic Cut-Off Procedure on your next job. And be sure you specify Union Tuffy Standard Rotary Line, Union Tuffy Jackknife Rotary Line and the Standard Union Oil Well Servicing Ropes. The best costs less on the long haul. For quick delivery, call your oil field supply store.

procedures are as quick as 1-2-3!

factors, mud or air drilling, etc. It's all charted—a total of 118,360 different answers! Our engineers select from the master book the ones that apply to **your** job. There is no guess work involved.

3. **The answer to your cut-off procedure problem** is rushed to you by our Union fieldman. So far as you're concerned the rest is easy. Only 5 or 6 simple charts usually is all that's required. Our fieldman will explain their use to you and your crew, all without cost. And he'll check back regularly with you to assure maximum safe service all the way. For more information and booklet on Cut-Off Procedures, contact **Union Wire Rope, Armco Steel CORPORATION, 2106 Manchester Ave., Kansas City 26, Mo.**

ARMCO **Union Wire Rope**



Look at the *precision threads* on CF&I Tubing and Casing

There's not a weak link in the lot. Every thread has the right lead, taper, height and size. The result is seamless tubing and casing that has *extra* strength and is pressure tight where it needs it most—at the critical area of the threaded connection.

CF&I Oil Country Casing and Tubing meet API STD 5A specification and are available in sizes from 2⅜" to 9⅝" O. D. Contact your nearby CF&I sales office or distributor for speedy delivery.

The Colorado Fuel and Iron Corporation
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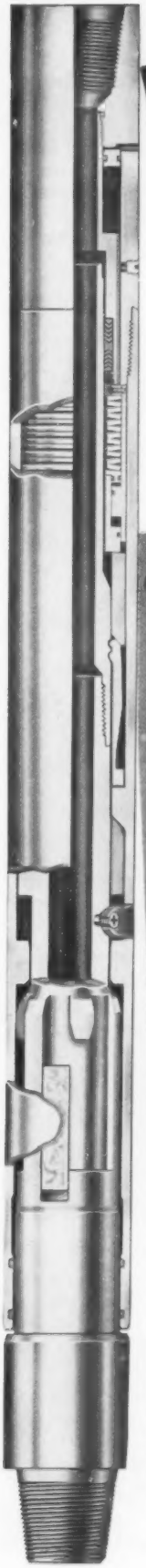

NEW TO THE OIL INDUSTRY!

THE SHAFFER "HYDRAULIC TRIP" JAR SAFETY JOINT

Positive "3-In-1" Protection Is A Major Advancement In Fishing Tool Design

Again Shaffer brings a major new oil tool advancement to the oil industry, a "3-In-1" Fishing Jar that combines, in one tool, the protection of a "Hydraulic Trip" Straight-Pull Jar . . . plus the protection of a *Mechanical* Trip "Standby"... plus the controlled releasing action of a positive Safety Joint in the event the fish cannot be loosened and it is desired to release the fishing string.

Never before has a single tool combining such a wide range of safety features been available to the oil industry!

1 USED AS A HYDRAULIC JAR

Normally used as a straight-pull "Hydraulic Trip" Jar, this new Shaffer tool permits the force of each blow to be easily controlled at the surface. The operator simply takes a pull on the fishing string. This pull, acting through a built-in hydraulic chamber, causes the desired blow to be struck as soon as sufficient fluid passes through an orifice in the tool—a matter of only a few seconds between the time the pull is taken and the blow is struck.

- The tool re-sets itself automatically when the string is lowered, and repeated blows can be struck by simply raising and lowering the string!
- No torque is required—either to strike the blow or to re-set the tool!
- The force of the blow can be easily controlled by noting the amount of pull registered on the weight indicator. To strike a heavier blow, merely increase pull. To reduce blow, take less pull. *It's that simple!*
- Once the desired pull has been determined, the entire operating sequence can be timed by the driller so there is no loss of time while tripping or re-setting the tool!

2 MECHANICAL TRIP STANDBY

If for any reason the "Hydraulic Trip" should fail to function, a simple manipulation of the run-in string by-passes the hydraulic system so that the tool can be operated *mechanically*. This is a marked improvement over other hydraulic Jars which become inoperative should the hydraulic system fail!

3 POSITIVE SAFETY JOINT RELEASE

Still another unique feature is the built-in Safety Joint in the lower portion of the tool. If the fish cannot be loosened, and it is desired to release the run-in string, simply trip the tool and apply left-hand torque as the string is slowly lowered. This rotates locking lugs into releasing slots so that the string and a major portion of the tool itself can be recovered. The recovered portion of the Shaffer "Hydraulic Trip" Jar Safety Joint can then be used at the bottom of any subsequent fishing string to simplify reconnection with the fish!

Ample Bore Diameter: So that wire line equipment can pass freely through the "Hydraulic Trip" Jar Safety Joint, it has been designed with a generous bore throughout its length. For example, the 5¾ O.D. tool has a full 2″ bore!

Fully Oil-Sealed: To prevent abrasive mud, sand or corrosive well fluids contacting the mechanism, all operating parts of the Shaffer "Hydraulic Trip" Jar Safety Joint are completely sealed in oil!

(Left) The Shaffer "Hydraulic Trip" Jar Safety Joint in "Set" Position

See your nearest Shaffer representative for full details on this latest Shaffer advancement. Or write direct!

38 years OF OIL TOOL LEADERSHIP

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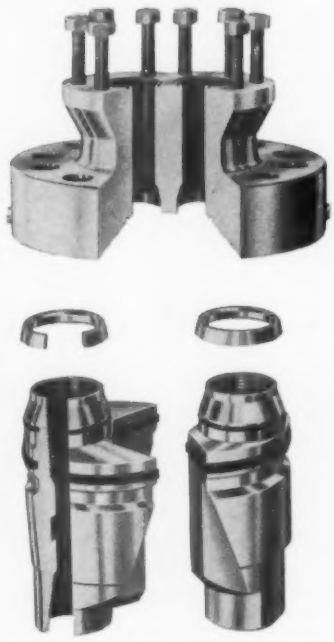
Rector "MCT" Triple Completion Tubing Head

Single, dual or triple . . . Rector's versatile MCT Tubing Head offers multiple tubing hanger arrangements that make it possible to complete a well with one, two or three tubing strings without changing the tubing head or using special attachments. All strings can be run independently without the removal of blow-out preventers. Hangers are automatically aligned in the head by fixed lugs that insure positive accurate seating without the use of guide pins. A special **RECTOR** multi-seal ring on each hanger in dual and triple completions insure positive steel seal for each tubing string. In single completion application, steel seal is obtained by use of an API ring gasket

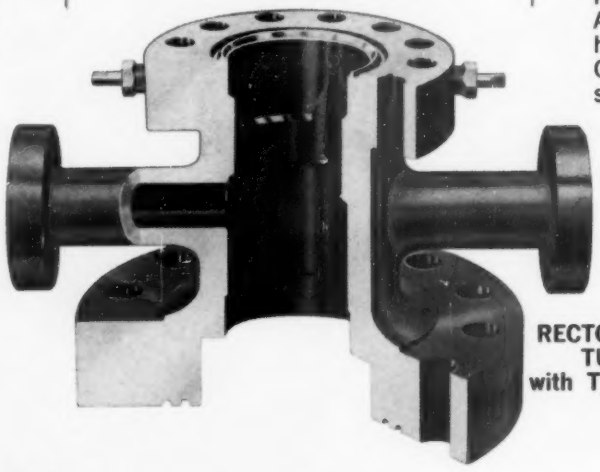
Resilient packing elements on all hangers along with removable **RECTOR-PSI** back pressure valves insure control of well during removal of blow-out preventers and installation of Christmas Tree.

For full information, contact your **RECTOR** representative or your favorite supply store.

Type "LST" Hanger and Adapter Flange
Single Hanger for use in "MCT" Tubing Head. Available with Back Pressure Valve Groove.



Type "TLCT" Hangers and Adapter Flange
Dual Hangers for use in "MCT" Tubing Head. Allows one string to be hung in tension. Grooved for Back Pressure Valve.



RECTOR TYPE "MCT" TUBING HEAD with Type "LCT" Triple Hangers

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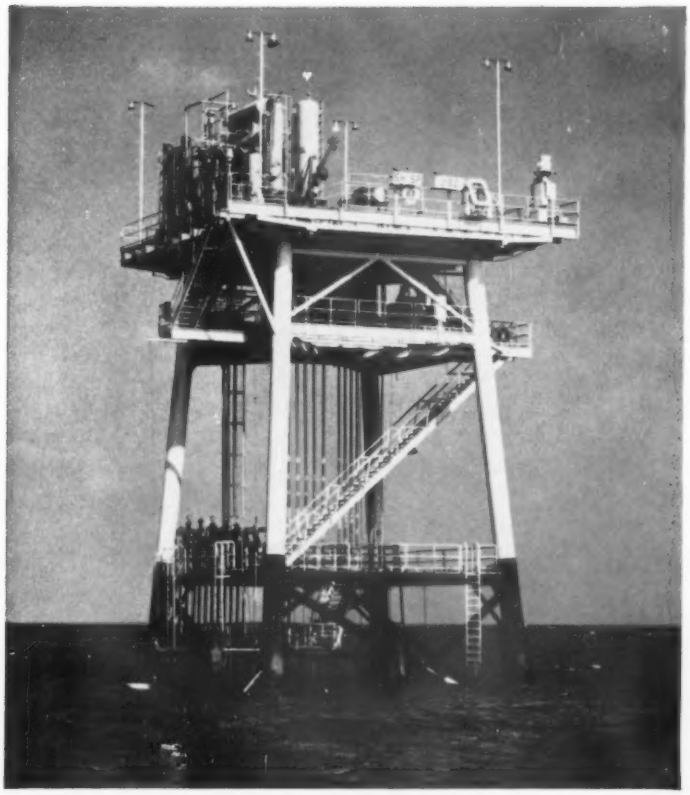

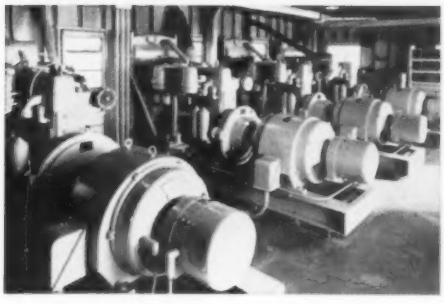

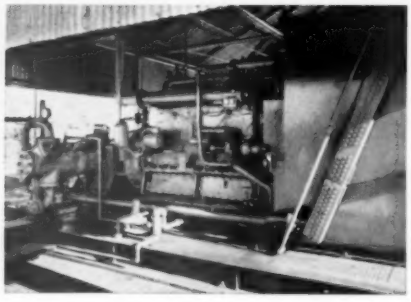

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BOTH DIESELS AND "BUILT-FOR-GAS" ENGINES

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SECURITY *thp*

gets you lowest cost per foot

It's a documented fact: Security now makes the finest bits in the industry. Further, Security ***thp*** . . . total hole program, using Security bits all the way . . . will save you thousands of dollars per year. Actual in-the-field tests . . . as illustrated by the typical chart below . . . have proved repeatedly that Security bits beat all penetration speed records in comparison with other bits used in similar drilling conditions. Security ***thp*** will pay off for you, too!

***TOTAL HOLE PROGRAM**

Security®

ENGINEERING DIVISION
Main Plant: P. O. Box 13647 • Dallas, Texas
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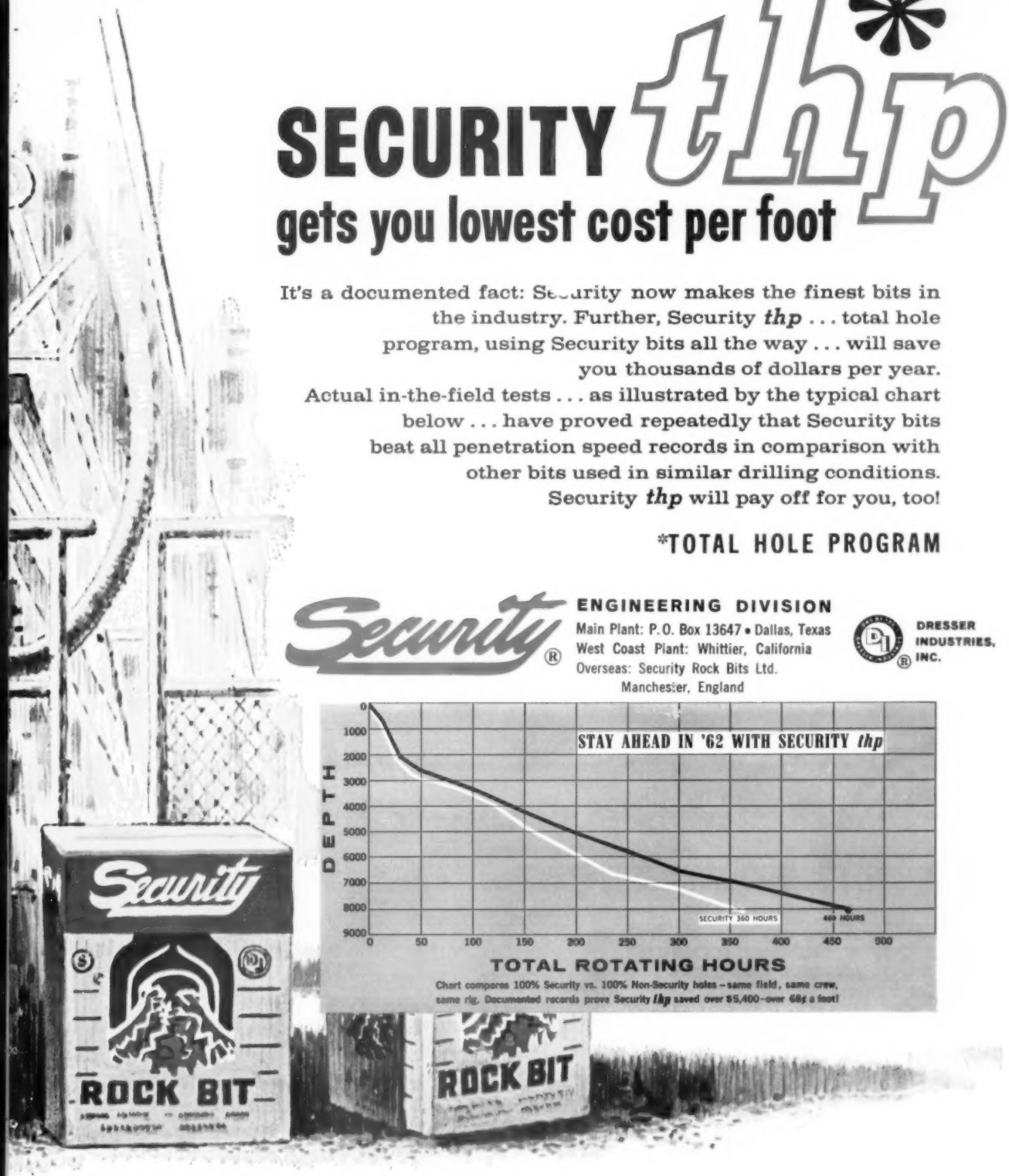
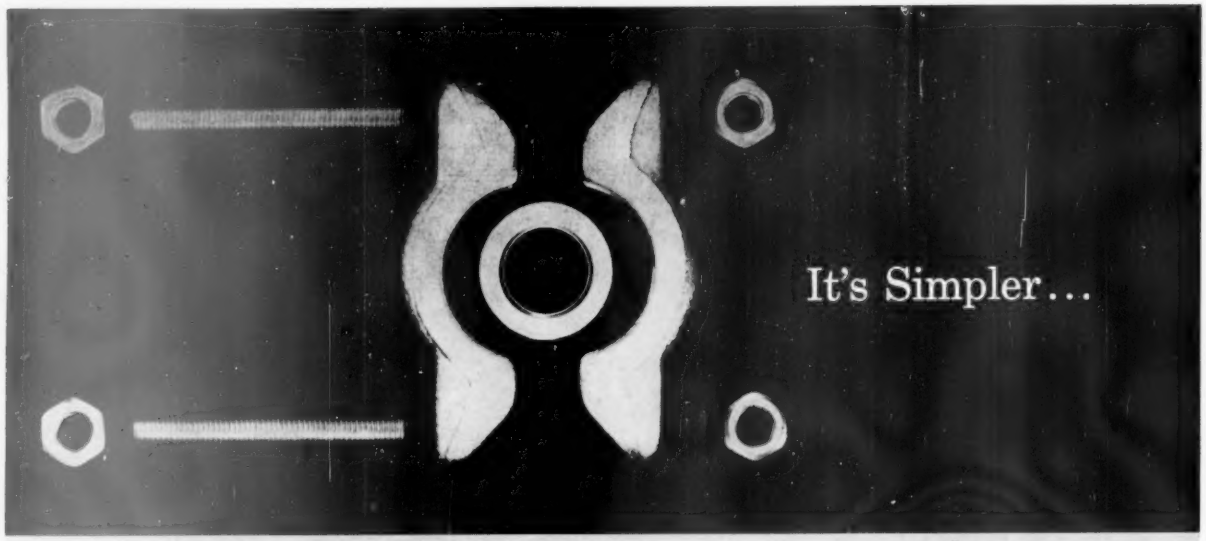
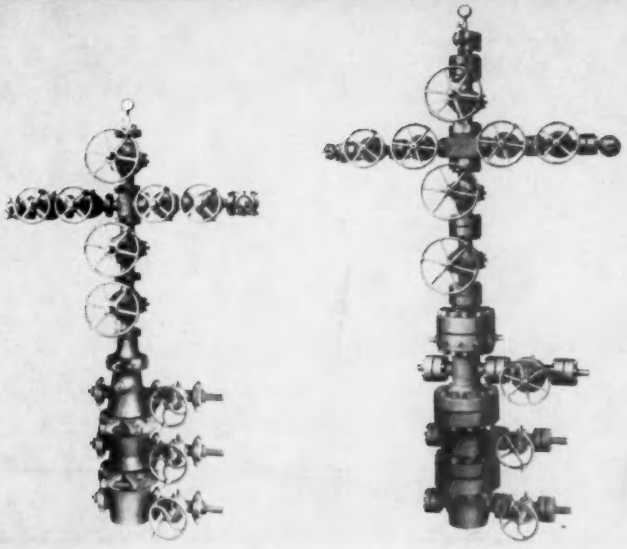
DRESSER INDUSTRIES, INC.





It's Smaller...



It's Better BECAUSE OF GRAYLOC

With only two bolts per connection, there's no simpler connection to assemble—and because *Grayloc*® connections require less space, the complete assembly is smaller. Yet for all its simplicity and compactness, *Grayloc* Wellhead Assemblies have been used on the highest pressure wells thus far discovered.

Grayloc connected assemblies are faster and easier to install, weigh less and are less expensive than equally rated flanged assemblies. They resist vibration and retain a tight seal after original assembly without further attention.

A Gray representative will be glad to show you how much better *Grayloc* connected wellhead assemblies can work for you. Write today for additional information and the Gray catalog.

GRAY *Tool Company*

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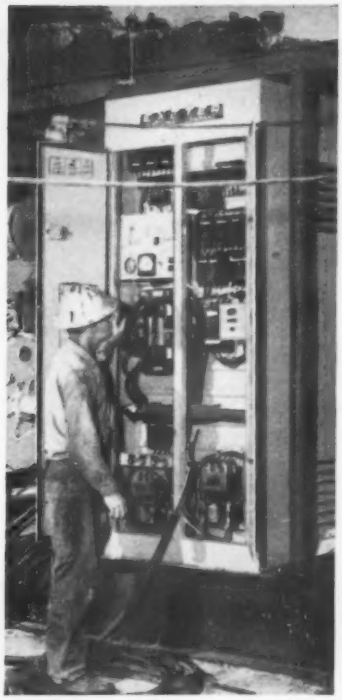
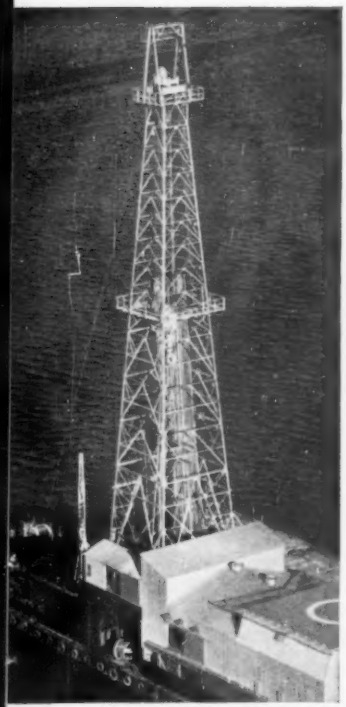
CASCADE—First diesel-electric drilling rig operating in Canada.



EXETER—First dual power generator assignment providing variable-constant engine speed control.

SLATS HONEYMON—First dual power output with independent speed control for mud pump and rotary.

HELMERICH & PAYNE First 2-speed draw works; driven by gear motors.



DIXIE—First electric drilling rig package for rotary table operation only.

CALDRILL—First diesel-electric powered drilling rig operating on an offshore California platform.

Progressive Contractors

DRILL ELECTRICALLY

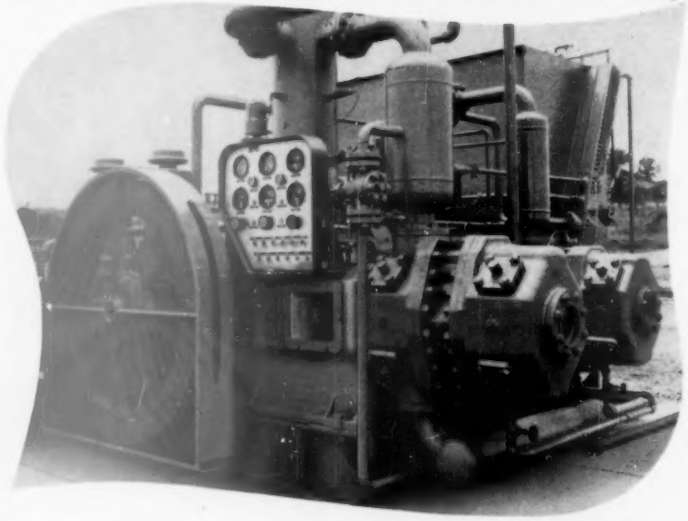
Installations confirm . . . up to 52% savings in maintenance costs, 75% less downtime from transmission difficulties, 35% reduction in transportation and rig-up time, 15% savings on fuel, and higher efficiency results in faster over-all drilling.

For new rigs or repowering existing ones, General Electric's engineers can help you select and apply the right electric drive for your needs, to improve your competitive position, increase flexibility and maximize rig life and operating profits. Write Oil Well Drilling, Section L102-01, Building 3-42, General Electric Company, Erie, Pennsylvania, for further information.

Progress Is Our Most Important Product

GENERAL ELECTRIC

AJAX INTEGRAL ENGINE-COMPRESSOR TWIN CYLINDER UNITS are designed to meet the need for LOW COST Units in the LOW+MEDIUM horsepower ranges.



120-160-230 BHP Sizes

Single and Two Stage

for

- Gas Gathering
- Gas Boosting
- Repressuring and Gas lift service
- Gas storage and Vacuum service.

SPECIFICATIONS

AJAX ENGINE-COMPRESSOR TWIN CYLINDER UNITS

MODEL COMPRESSOR	DPC-230		DPC-160		DPC-120	
	ENGINE	COMPRESSOR	ENGINE	COMPRESSOR	ENGINE	COMPRESSOR
GENERAL						
Bore x Stroke, Inches	Twin 13¼"x16	11" Stroke	Twin 11" x 14"	11" Stroke	Twin 9½"x12"	8" Stroke
Displacement, Cu. Inches	2x2206		2x1330		2x850	
Brake Horsepower – A.P.I.	230		160		120	
Available Compression B.HP	220		150		110	
B.M.E.P. – PSI	57.5		59.5		59.0	
Rated R.P.M. (Min. - Max.)	250 - 360	250 - 360	250 - 400	250 - 400	250 - 475	250 - 475
Piston Speed – Ft./Min.	960	660	933	733	950	635
MAIN BEARINGS						
Type of Main Bearings	Double Row Non-Adjustable Tapered Roller					
Bore of Main Bearings, In.	Two 7¼" and One 12"		Two 6¼" and One 12"		Two 5⅝" and One 10"	
CRANK PIN BEARINGS						
Diameter x Length, Inches	(2) 7½"x3⅝"	(2) 7½"x3⅝"	(2) 6¾"x3⅞"	(2) 5¾"x3⅝"	(2) 5¾"x3⅜"	(2) 5¾"x3⅝"
CROSSHEAD PIN BEARINGS						
Diameter x Length, Inches	(2) 5½"x4¾"	(2) 3¾"x4⅛"	(2) 3¾"x4⅛"	(2) 3¾"x4⅛"	(2) 3¾"x3¾"	(2) 2¾"x3⅜"
PISTON ROD						
Diameter, In.	2½"	2½"	2	2½	1¾	1¾
Pin Load Per Rod, In.		20,000		16,000		10,000
FLYWHEEL						
Outside Diameter, In.	56		52		48	
Weight, Lbs.	2250		2225		1700	
WD2 - Ft.2 Lbs.	37500		30000		20200	
STARTING						
Minimum Air or Gas Pressure	200 PSI		200 PSI		200 PSI	
PIPE CONNECTIONS						
Fuel Gas, Inches Per Cylinder	1½		1½		1	
Starting Inches	1		1		1	
Exhaust						
Diameter, Inches Each	8		6		5	
Length, Feet Each	6000/RPM		5600/RPM		5250/RPM	
LUBRICATING						
Method	Controlled Splash Lubrication to Bearings and Crossheads Force Feed to Power Cylinder Walls and Compressor Cylinder Walls and Packing					
CRANKCASE CAPACITY	30 Gallons		28 Gallons		25 Gallons	
APPROXIMATE WEIGHT						
Without Gas Cooling, Lbs.	29,500		22,700		18,700	
With Gas Cooling, Lbs.	33,500		26,000		21,500	
APPROXIMATE FOUNDATION REQUIREMENTS						
Cu. Yds. Concrete	19		16½		13½	
MAGNETO						
Type	HIGH TENSION – WEATHER PROOF					
Drive	GEAR DRIVEN FROM LAYSHAFT					

ALWAYS A FULL DOLLAR'S VALUE IN AJAX PRODUCTS

AJAX COMPRESSORS

ALSO BUILDERS OF

ENGINES . . . PUMPS

AJAX IRON WORKS CORRY, PENNSYLVANIA

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- Bethlehem Steel Co. – Supply Division, Tulsa, Oklahoma
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- Beacon Supply Co., Pampa, Texas

South Penn Completes Alcohol Slug Injection

South Penn Oil Company's alcohol slug experiment, which began in the Bradford field about a year ago, is reaching the close of the first phase of this operation.

The unique experiment is regarded as a step towards developing a tertiary recovery method for crude oil and is located on South Penn's B. C. Haven property in Pennsylvania's Bradford field. Cost of the experiment is estimated at approximately $325,000.

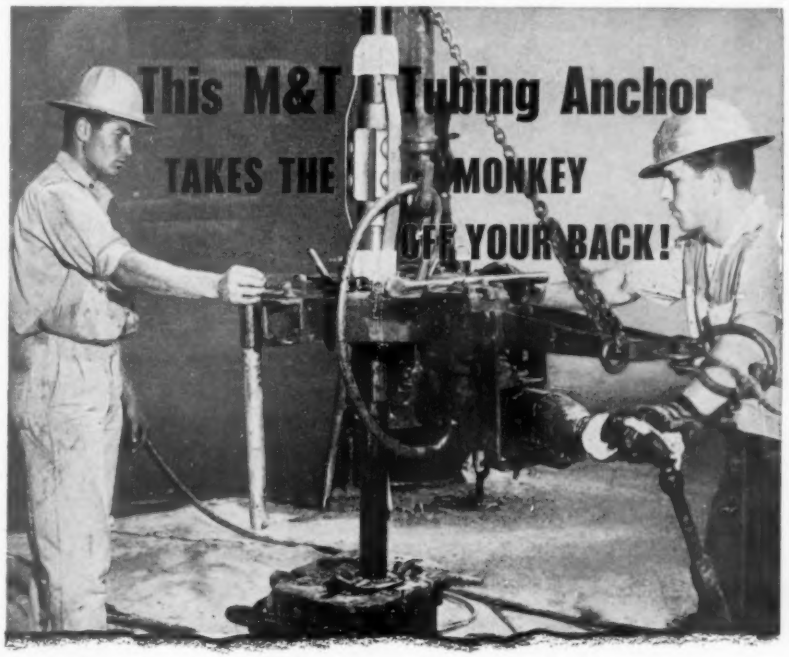
Since September 19, 1960, when the injection of isopropyl alcohol was started into four intake wells, about 28,000 bbl of this material has been pumped into the Bradford Third sand reservoir. This constitutes a slug which is approximately 15% of the pore volume estimated for the twelve acres which will be affected. Injection of the straight alcohol has been completed.

South Penn is now injecting a mixture of water and alcohol, at a four to one ratio respectively, to achieve a graded viscosity zone between the alcohol and the water which will be injected behind it. Injection of straight water will be resumed after the mixed slug is injected.

To date there have been no appreciable changes in production from the producing wells and it is not anticipated that any significant results will be forthcoming from this experiment until sometime in 1962.

The B. C. Haven lease on which this pilot test is being conducted has been under intensive five-spot pattern water drive for almost eleven years and is approaching its economic limit. Injection of water is continuing into the area around the alcohol five-spot, and no changes have been made in the operation other than to segregate production from the nine producing wells adjacent to the alcohol intake wells. Each of these wells is individually gaged for a weekly period once each month. Water production is gaged both in the tanks and through a recording weir.

As a further aid to analyzing fluid movements in the reservoir, tracer tests have been conducted under the supervision of the Bureau of Mines, Bartlesville office. The Department of Petroleum and Natural Gas at the Pennsylvania State University is cooperating closely with the operations on all phases of this experimental project.



What does that mean? It means you've got more time for other duties, because the M&T Compensating Frictional Tubing Anchor can be run by your own crew without your supervision.

Oh, sure, and they'd run it upside-down! No matter. The M&T Anchor works with equal effectiveness either way. Just run it in the hole and start the pump. That sets the anchor. Positively. Pressure does the work. *And* — no wickers to damage casing.

H'm. How do you get it out again? No trouble there, either. Unseating the pump releases the M&T Anchor. You can move it or pull it at any time, under any conditions . . . wet or dry . . . no bleeder valve needed . . . no risk of a costly fishing job.

Sounds good. How about maintenance? The lowest! 1,300 M&T Tubing Anchors are currently at work in the oilpatch, with less than 2% maintenance. M&T dependability holds costs down!

You can get more info from your McGaffey-Taylor or Eastman Oil Well Survey field man . . . today!

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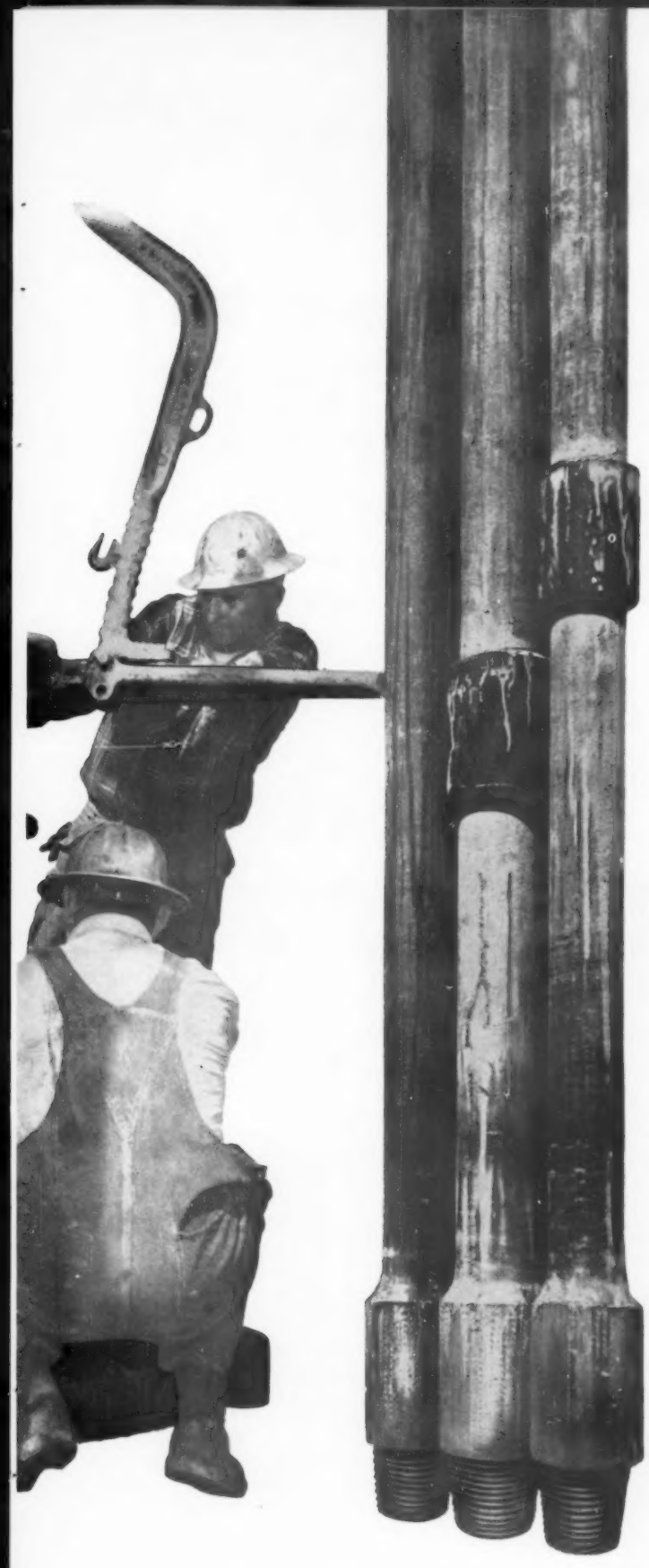

SUCCESSFUL COMING OUT PARTY!

It's successful because it goes strictly according to plan. Up comes over 8000 feet of J&L Seamless Drill Pipe to make a perfect trip. What happened here—what the picture shows—is normal, routine, planned, and always important. A professional crew **expects** a trouble-free trip . . . **expects** drill pipe to come out of the hole in good shape. Ask around. J&L Drill Pipe has a reputation for meeting your best expectations. The reputation has been earned the hard way—in action—on countless drilling jobs. J&L Casing and Tubing have the same top reputation for quality. Reason: J&L has invested millions in the best tubular production and testing equipment known. Talk performance and value with your J&L salesman soon.

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J&L STEEL

Running Tour

Oliver W. Fowler is now associated with Rocky Mountain Natural Gas Co. and headquartered at Glenwood Springs, Colo. He formerly was assistant field superintendent for El Paso Natural Gas Co. at Farmington, N. M.,

Wayne E. Swearingen has been appointed executive vice president in charge of expanded exploration, waterflooding and land acquisition activities for Livingston Oil Co., Tulsa, Okla. Recently he owned and operated his own consulting engineering firm in Tulsa.

Shell Oil Co. has named J. H. Pittinger to be division production manager of the Houston production division. He succeeds H. K. McKinnon who has been assigned to the area production department. Prior to his new appointment, Pittinger was on a special assignment in the Houston area exploration department.

W. C. (Dub) Tillett has resigned as exploration superintendent of Tenneco Oil Co.'s Midland district to become an independent operator. He has opened an office in the Petroleum Life Bldg. in Midland, Tex.

Clayton Nygaard will move from Billings, Mont., to Calgary, Alta., Canada, to become Ambassador Oil Corp.'s district production superintendent there. He has served with both Standard Oil Co. of Ohio and Standard Oil Co. of Indiana in their production and engineering departments.

Two staff changes have been made by James G. Brown & Associates in its Midland office. Warren G. Hicks, formerly with Republic Natural Gas Co., has been named West Texas and New Mexico division geologist. William D. Barnes was appointed exploration manager of the firm. Previously he was Amarillo district exploration manager.

Humble Oil & Refining Co. has promoted Jack Shepherd to operations superintendent of the company's Midland (Tex.) area. He has been Andrews district manager for the last six years. Shepherd replaces John S. Boldrick, recently transferred to Houston, Tex., as manager of that area office.

Joe Worshing has been named district supervising engineer of

ECONOMY – VERSATILITY IN WELL COMPLETIONS

PSI MODEL S
SLIDING SLEEVE

PSI MODEL S SLIDING SLEEVE offers outstanding economy and versatility in wells where tubing casing communication is desirable. As many Sliding Sleeves as needed may be installed in a given string, and it is possible to operate standard wire line tools in as many as three of the sleeves.

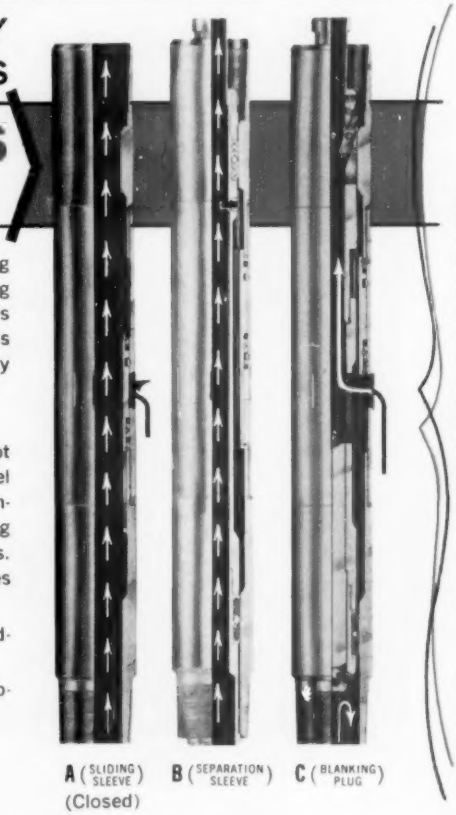
ILLUSTRATED AT RIGHT

A. Upper and lower subs are internally honed to accept the PSI Model SYE Separation Sleeve and PSI Model SVP Blanking Plug. Opened and closed by conventional wire line methods. Large I.D. to permit running and pulling of pressure bombs and perforating guns. PSI designed metallic reinforced packing insures sealing under well differential pressures.

B. Separation Sleeve installed to test or pack off Sliding Sleeve.

C. Blanking Plug installed to isolate lower zone or produce upper zone through tubing.

NO NEED FOR ADDITIONAL SUBS OR NIPPLES TO GIVE THE UTMOST IN ECONOMY



A (SLIDING SLEEVE) (Closed) B (SEPARATION SLEEVE) C (BLANKING PLUG)

PSI

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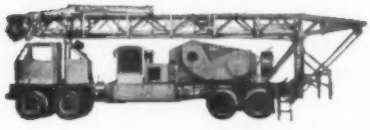

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Before you buy get the facts on light weight... low cost... long life Winchmobile Junior with the cross mounted engine which saves moving parts and increases hp to the drum by 15%!

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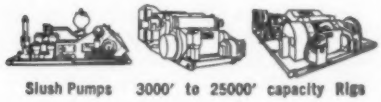


Slush Pumps 3000' to 25000' capacity Rigs

Humble Oil's Monahans district. He was formerly in the company's Andrews district office.

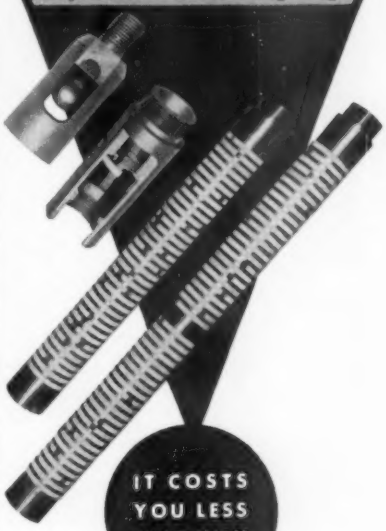
Partners of Lyons & Logan, Shreveport, La., have reorganized into Lyons Petroleum and established an office at Lafayette. Charlton H. Lyons, Sr., is senior partner of the new firm. Other partners are C. H. Lyons Jr., E. L. Hilliard, Hall M. Lyons, G. F. Abendroth, John T. Palmer and J. A. Dykes. Gene M. Griswold, Shreveport attorney, is counsel, and Charles A. Barton is to be South Louisiana geologist at Lafayette.

G. W. Crickmay has assumed his duties as manager of the Canadian region of Atlantic Refining Co.'s domestic producing department. He is succeeded in his former post as vice president and general manager of Venezuelan Atlantic Refining Co. in Caracas by Richard Chadwick-Collins, formerly assistant manager of the company.

Charles L. Bare has joined Continental Oil Co. as a research scientist in the production research division. He will specialize in computer applications in Conoco's recovery processes section, with headquarters in Ponca City, Okla. The company also has reorganized its international exploration activities into four major areas. The areas and their exploration managers are: Europe and French Community, D. B. Eicher, formerly staff geologist at Houston, Tex.; Africa, J. R. Strong, formerly New York senior staff geophysicist; Eastern Hemisphere, J. F. Mason, formerly New York staff geologist; and Western Hemisphere, W. A. Peterson, formerly New York staff geologist. Europe and French Community area manager is J. F. Tolleson, formerly Paris representative.

Several key staff changes have been made in Gulf Oil Corp.'s domestic production operations. W. E. Bauman is promoted to area production manager at Amarillo, Tex., replacing E. A. Weichert who transfers to the Midland, Texas, district. M. R. Smith is promoted to district engineer at Denver, Colo., Bauman's former post. E. E. Clapham, formerly district reservoir engineer at Midland, succeeds Smith as Monahans, Tex., area engineer. J. N. Newmeyer is advanced from senior petroleum engineer at Midland to district reservoir engineer. At Houston, Tex., E. A. Ehlers Jr. is promoted to district reservoir engi-

Let R-u-b-b-e-r Take The Wear in your sucker rod pumps



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• MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

• MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

• The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

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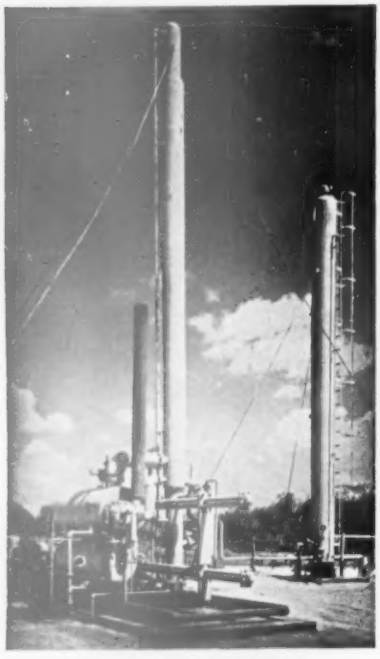
Sweeten Sour Gas More Economically



with the NEW MALONEY-CRAWFORD SWEET-A-MINE

Maloney - Crawford technology makes low-cost, highly efficient amine desulferization a reality with the new Sweet-A-Mine. Whether you have 400 MCF/D or 50 MMCF/D of sour gas, a Sweet-A-Mine will give you specification gas . . . with virtually no field attendance.

The Sweet-A-Mine is in two assemblies—absorber and regenerator. The sour gases are absorbed in a solution of monoethanolamine and water, then the sour amine solution is regenerated for re-use. A special feature is a reflux condensing coil that boosts the efficiency of the regenerating process.

With these advances in mind, re-examine your sour gas problems. Tell us your conditions. M-C engineers have the answer. Contact them.

Maloney-Crawford

P. O. Box 659 Tulsa, Okla.

neer succeeding C. F. Kalteyer, now district production engineer there. Z. C. Ballinger, formerly Houston district production engineer, transfers to Hobbs, N. M., as area engineer replacing C. M. Bumpass, now area engineer at Kilgore, Tex. C. W. Alcorn Jr., area production geologist, is transferred from Andrews, Tex., to Victoria.

Lion Oil Co., a division of Monsanto Chemical Co., has announced two new "resident geologists" in its scientific advancement plan for geologists and geophysicists. They are: Carl E. Youngren, district geologist for L-M Oil Co. Ltd.; and Leslie W. Andrews, senior geologist for Lion's Denver, Colo., district. Also reassigned are two petroleum engineers: Edward M. Scholl, from the Diamond "M" district at Snyder, Tex., to the Denver district production office; and Henry S. Weigel from Denver to Snyder.

Richard R. Gray has been named general engineer in the production department of the Ohio Fuel Gas Co. For the past five years he has served as northern and central district production engineer.

Phillips Petroleum Co. has promoted F. C. Jones to the newly created position of assistant manager of its Venezuela operations in the exploration and production division of the international department. Jones will continue as operating department head at Caracas. The firm also has promoted R. L. Rayl to division exploration geologist in the Denver, Colo., office of the land and geological department. He succeeds A. Haig who has transferred to the geological staff of the department's headquarters in Bartlesville, Okla.

Harold F. Winham of Shell Oil Co. is 1961 recipient of the certificate of service of the Society of Petroleum Engineers of AIME. Prior to his association with Shell, Winham was petroleum engineer for Marland Oil Co. and exploitation engineer for Caribbean Petroleum Corp. at Maracaibo, Venezuela. He has served Shell as exploitation engineer in East and West Texas, as well as in Louisiana, and is currently district superintendent in South Louisiana.

Preston P. Nibley has joined Socony Mobil Oil Co. Inc. as an engineering consultant. He formerly was manager of operations in New York for Trans-Arabian Pipe Line Co.

D. K. Dressback, treasurer of Tekoil Corp., has been elected president and treasurer, director and executive committee member for both Tekoil and its wholly-owned subsidiary, Petroleum Technologists Inc. This action follows the resignation of two officers who plan to devote their full efforts to foreign waterflood development. They are: W. H. Davison, formerly Tekoil's president, director and executive committee member and Petroleum Technologists' vice president and board member; and K. Davison, formerly vice president and director of Tekoil and vice president and board member of the subsidiary.

Texas Mid-Continent Oil & Gas Assn.'s new president is J. Clyde Tomlinson, independent oil producer and mayor of Longview, Tex. He succeeds Estill S. Heyser Jr., Dallas independent producer. Tomlinson has served Texas Mid-Continent also as district vice president for East Texas, is a director of general Mid-Continent Oil & Gas Assn. and a director of the Independent Petroleum Assn. of America.

Other officers elected at the 42nd annual meeting in Ft. Worth, Tex., include: Charles E. Simons, executive vice president; William H. Abington, general counsel; and Eugene McElvaney, treasurer. New district vice presidents are: Norman E. Loomis, East Texas; Netum Steed, North Texas; R. C. Tucker, Permian Basin; Frank P. Zoch Jr., Lower Gulf Coast; Rip C. Underwood, Panhandle; H. E. Dishman, Upper Gulf Coast; Alvin C. Hope, Southwest Texas; Harold Decker, Middle Gulf Coast; J. C. Hunter Jr., West Central Texas; and Hamilton Rogers, North Central Texas.

Joining the exploration department of Monsanto Chemical Co.'s Lion Oil Co. Div. at Denver, Colo., are Waring R. Gordon and Sigmund J. Rosenfeld. Both formerly served with Shell Oil Co. in Denver.

Phillips Petroleum Co. has promoted Richard D. Miller to Shreveport division landman and Harold A. Kuehnert to Denver division development geologist.

F. T. Connolly has been named chief geologist in Shell Oil Co.'s Houston area exploration department. Prior to this appointment, he was manager of the geological department of Shell Development Co.'s exploration and production research division.

D & P Equipment

Controls Plugging Deposits

Parid dispersant effectively removes or prevents plugging deposits (of asphaltenes, bitumens, paraffins and other substances normally insoluble in crude oil) that accumulate on rods and in well tubing, flowlines, pipelines and tanks. It functions not as a solvent but with a wetting and detergent action dependent on presence of free water in the system treated. It is an organic compound, soluble in hydrocarbons and dispersible in fresh water or brine, will not corrode production equipment and is available in liquid or solid stick form. *Tretolite Co., Div. of Petrolite Corp.*

Circle number (1) on reply card

Cutter Equipped for Plastic

A specially designed cutting wheel converts the Ridgid No. 205 tubing cutter into a plastic pipe cutter in seconds. For thin or heavy wall rigid plastic pipe, the cutter has a capacity of up to 2-in. Schedule 120 plastic pipe (¼-in. wall thickness). A specially designed radius eliminates both internal and external burrs. Absence of the latter insures uniform distribution of solvent on the inner surface of the fitting when making up a joint. An absolutely perpendicular cut, equally essential in forming proper joints, is guaranteed with each cut. The special wheel may be removed or inserted in seconds and stored in the cutter's handle. *The Ridge Tool Co.*

Circle number (2) on reply card

Tool Joints Better Protected

Hardfaced Spangweld tool joints are better protected now on the tapered shoulder. The annular band of hard carbide is extended over the area in which three small pads formerly were spaced 120 deg apart. Replacement of the pads increases hardfacing 45% on the shoulders of 4½-in. Spangweld internal flush tool joints. Shoulder band width is increased from ⅝ in. to 1 in. on all sizes up to 4½ in. Total hardfacing band width is still 3 in. The improved protection is provided by shifting the band ⅜ in. farther down on the 18-deg elevator shoulder of all sizes. This extends the band 1 to 1½ in. on the shoulder, depending on tool joint size, without interfering with seating of elevator against shoulder. *National Supply Div., Armco Steel Corp.*

Circle number (3) on reply card

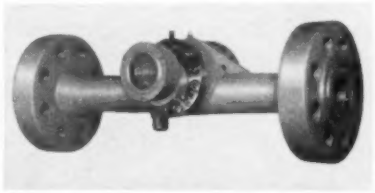
Rod for Heavy Pumping Loads

A special alloy sucker rod has been developed to meet the need for a rod with strength to carry heavy pumping loads in non-corrosive fluids or mildly corrosive fluids that can be effectively inhibited. Where corrosion is not a problem, the manufacturer points out, it is more economical to utilize the new type S rod than more expensive, high tensile rods designed to resist corrosive fluids. This chrome-moly sucker rod with typical tensile strength of 130,000 psi is available in ⅝, ¾, ⅞ and 1-in. sizes, with stress-relieved pin with rolled threads optional. *Liberty Manufacturing Co. of Texas.*

Circle number (4) on reply card

For Waterflooding Use

New 2-in. Rotron Whirl-Flo flowmeters, models L2S-H and G 25-H, provide economical and accurate means of measuring liquid flow and gases, respectively. Pressure rating is 5000 psig. A natural vortex de-



velops in an offset chamber in the side of the pipe. There is linear relationship between the number of revolutions of the vortex and the volume of the main flow. Volume flowing through the meter is read by counting the revolutions of the rotor within the vortex. This rotation is transferred to the outside by magnetic couplings and can be presented as flow rate and/or integrated flow signal. Each meter is fitted with adjustable internal bypass that serves as a calibrator. *Rotron Controls, Div. of Rotron Manufacturing Co. Inc.*

Circle number (5) on reply card

Variable Speed Transmissions

Infinitely variable speeds that can be changed with transmission either running or stationary highlight a new line of completely redesigned metallic traction transmissions. The 1/6 to 1½-hp transmissions feature: built-in overload protection; one-piece housing to insure proper parts alignment and prevent leaks; unitized control assembly to prevent lost motion or backlash; new gear tooth form to produce 10% greater power and quieter operation; new input and output shaft mountings to provide increased overhung load capacity and better shaft alignment; removable oil window; new speed control stops; new dial and handle to provide micrometer speed adjustment to 1 part in 4000; and new motor construction to eliminate end play. They are furnished with all types of motors or without motor, and with or without built-in gear reduction or step up. *Graham Transmissions Inc.*

Circle number (6) on reply card

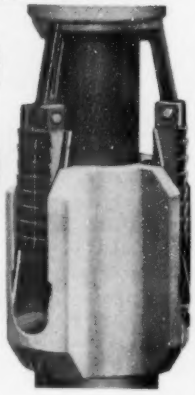
Chain-Drive Slush Pump

High speed quadruple roller chain, instead of conventional herringbone gear, transmits drive power for a new 5-in. by 6½-in. duplex reciprocating slush pump. Power end of the FM-45 is a one-piece unit with integral eccentric shaft and jackshaft bearing supports. Fluid end is a one-piece casting with conventional type pot valves. The lubricator packing gland provides positive lubrication to piston rods at points of greatest wear. Connecting rods are one-piece steel, with renewable steel-backed bushing for eccentric bearings and brass cross head bushings. API No. 1 taper rods and pistons are available. *The George E. Failing Co.*

Circle number (7) on reply card

DOUBLE-E

TENSION TUBING ANCHOR



SAFE

Slip flanges shear when unable to rejay anchor for removal from well.

PROVEN

Double-E tension tubing anchors have been field proven for over seven years.

EFFICIENT

Rod and tubing wear troubles virtually eliminated, pump efficiency increased.

The unique fracture flanges on the slips, originated by Equipment Engineers, is your insurance of a positive method of retrieving the tubing.

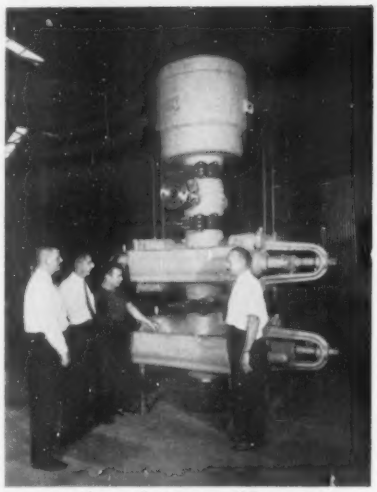
Sold Through Supply Stores — Write for Catalog and Prices

EQUIPMENT ENGINEERS, INC.

2039 Amelia St., Dallas 35, Texas • MElrose 1-2290

leaders for 30 years in well completion & pumping equipment

Modified for Quick Rig-Up



Joe Stine Inc. has modified Zapata Off-Shore Co. blowout preventers (13⅝-in. -3000 psi and 10-in. -5000 psi) with a new Cameron clamp connection at each end that has only two bolts to tighten. The new connection is a swing bolt clamp utilizing thick, self-sealing metal ring gasket, type BX, which is away from the flow of abrasive fluid. In addition to clamp connections between blowout preventers, the 4-in. outlets of the drilling spool also have been changed to clamp connections. In connecting choke manifolds to these outlets, further time is saved when converting from 3000 psi to 5000 psi preventers because the 4-in. clamp connections on the choke manifolds fit the outlets on both hook-ups. Shown inspecting the modification are; Ian Figart, Zapata Off-Shore Co. vice president; Joe Stine; Paul N. (Red) Adair of Red Adair Co. Inc.; and Allison Peters of Joe Stine Inc. *Cameron Iron Works Inc. and Joe Stine Inc.*

Circle number (8) on reply card

"LATE LIGHTS"
To Serve You . . .
Seeking . . . and finding, better communication systems is part of our life at USI. Sure in the knowledge that one of our systems can serve you best, we invite your next bid. Better still, why not call us today!
TYPE 50A PX
TYPE 50B PX
UNITED STATES INSTRUMENT CORP., CHARLOTTESVILLE, VIRGINIA

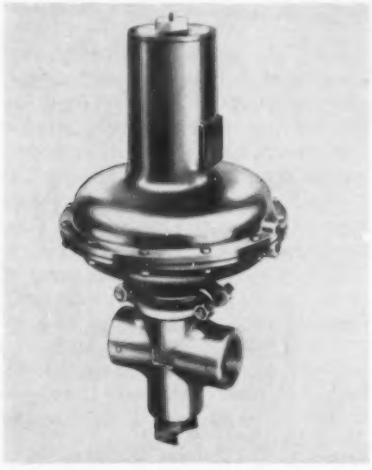
Paraffin Inhibitor

A complex organic formulation has been introduced to inhibit paraffin deposition and to disperse existing accumulations in flow lines, gas lift wells and tank bottoms. A liquid — soluble in crudes, insoluble in water — it contains no chlorinated hydrocarbons or heavy metals and may be stored outdoors. *Hagan Chemicals & Controls Inc.*

Circle number (9) on reply card

Valve Takes Less Inventory

Designed primarily for "on-off" applications in high pressure service is the BS&B type 70-23 diaphragm-operated dump valve that can be converted to either globe or angle by merely relocating the body



nipple. No additional parts are required to reverse the actuator. Seat cages are interchangeable for a given body size and the same inner valve is used for all orifice sizes. Another design feature is clamp ring mounting of actuator to body. All body internals, including seat ring, lift out when actuator is removed. The steel valve body is rated at 4000 lb and is available in 1 and 2-in. sizes. *Black, Sivalls & Bryson Inc.*

Circle number (10) on reply card

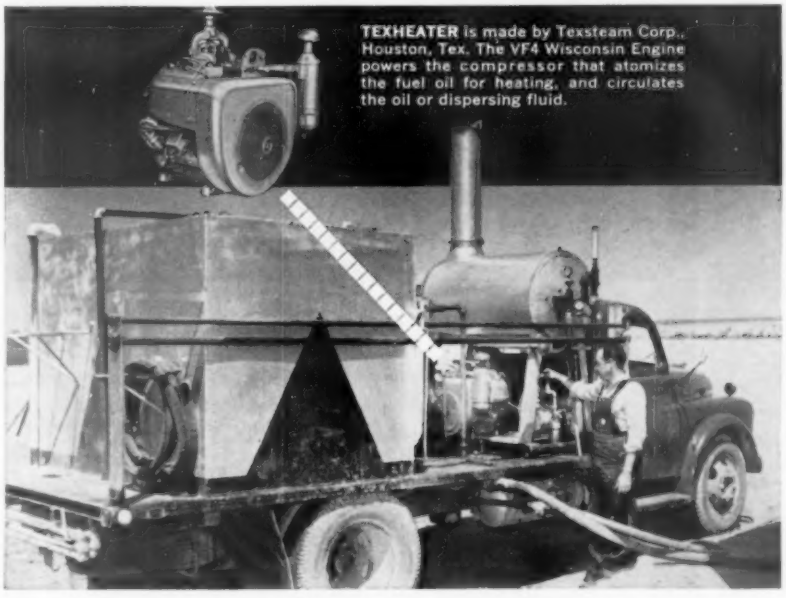
750-Bhp Packaged Compressor

Extending to 750 bhp the horsepower range of Clark CFA-CFB packaged field compressors is new model CFB-4 for gas lift, repressuring, pressure maintenance and air drilling. This completely self-contained compressor station, bulit in sizes from 400 to 750 bhp, uses a 5-in. stroke, 4-cylinder, balanced/opposed compressor with extra heavy case and running gear to accommodate the higher loading. Operating at 1000 rpm, compressor is directly connected to oil field type engine by flexible coupling. Belt and gear drives are eliminated. Because vibration is virtually eliminated, the package can be mounted on any support that will hold its weight . . . barges, trailers or concrete slabs. Both lined and unlined cylinders (36 standard sizes ranging from 2¼ to 21-in. diam and covering a pressure range from vacuum to 6000 psi) can be mounted interchangeably in any combination. All components are mounted on rigid steel, transportable skids. No field assembly is required. *Clark Bros. Co., Div. of Dresser Industries Inc.*

Circle number (11) on reply card

10½-Lb Cutter, 12-Ton Force

Three Pneudraulic rod cutters, the smallest of which weighs only 10½ lb but delivers 12 tons of cutting force, are described as ideal time-savers for snipping reinforcing bars, alloy steel rods and bolts up to 1-in. diam. These hand-held tools, capable of delivering up to 27½ tons of cutting force, are powered by remotely controlled, portable power cell about the size of a canister-type home vacuum cleaner. Mounted on casters and light enough to be carried anywhere, this cell converts normal shop air pressure into hy-



TEXHEATER is made by Texsteam Corp., Houston, Tex. The VF4 Wisconsin Engine powers the compressor that atomizes the fuel oil for heating, and circulates the oil or dispersing fluid.

WISCONSIN-powered "Texheater" delivers 2,500,000 BTU/hour to heat oil or additives

You can use the truck-mounted unit shown wherever you need quick, sustained heat. You can heat oil to prevent build-up of amorphous paraffin deposits in lines and connections—or to heat and circulate paraffin-dispersing additives at discharge temperatures up to 500° F.

Dependable power is supplied by a four-cylinder heavy-duty air-cooled Wisconsin Engine. It is precision-built for peak efficiency with minimum wear — and to require the least care.

The Wisconsin's high torque prevents stalling under changing loads. Air-cooling permits efficient operation at extremely high ambient temperatures and greatly simplifies servicing — a blessing in oil field operations.

See us for utility units and let us tailor the Wisconsin Engine you need for trouble-free all-weather operation. Send for Bulletin S-283 on the entire Wisconsin line, 3 to 60 hp.

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Oil Field Distributors for Wisconsin Engines and all types of Utility Units

World's Largest Builders of Heavy-Duty Air-Cooled Engines

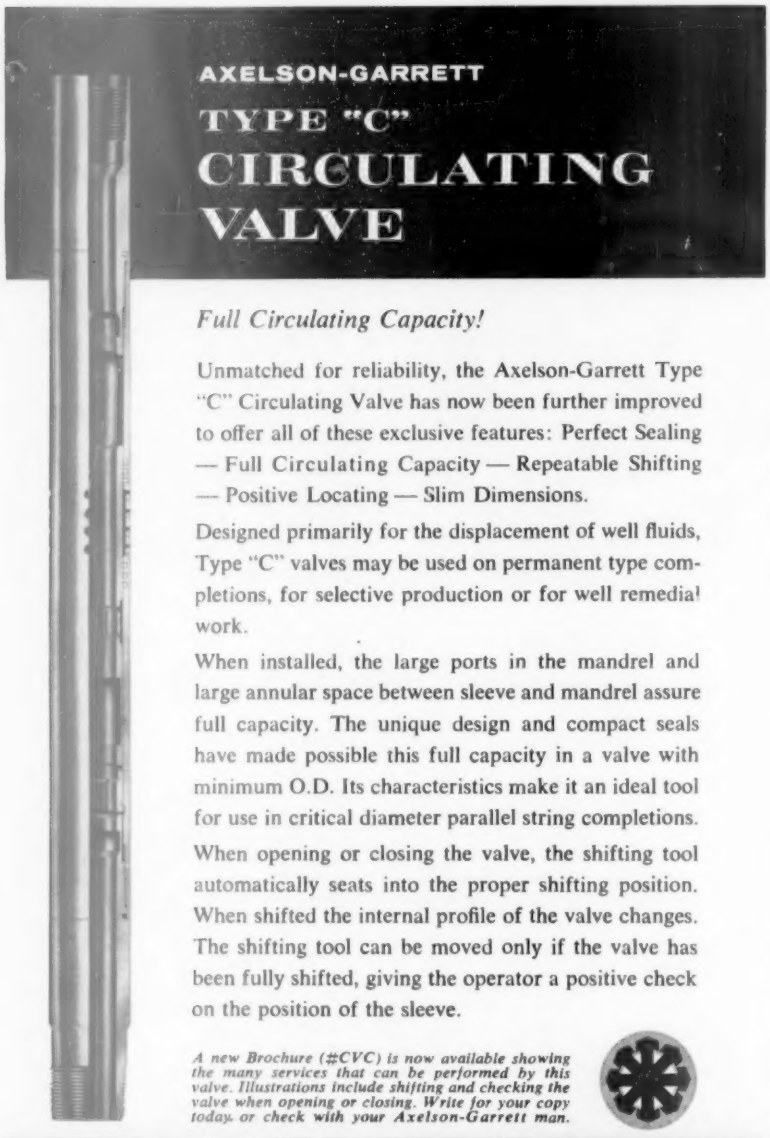
draulic pressures up to 7000 psi. Since there are no electrical components, the equipment can be used in damp or hazardous areas. A movable handle can be mounted at right angles to the tool cylinder or in line with it. *Chicago Pneumatic Tool Co.*

Circle number (12) on reply card

Portable Electronic Counter

Operating either from conventional 115-v a-c power or from a 12-v vehicular storage battery is a portable, solid-state electronic counter for use with provers in calibrating positive displacement meters. Designed for rugged field service, Model 331 weighs only 16-lb and is housed in a Halliburton aluminum case 13 in. by 18 in. by 6 in. Controls are simple, connectors to prover and pulser clearly labeled and keyed to eliminate hook-up errors and count total is displayed in large line Nixie tube numerals. Special test circuit enables operator to check each decade of 5-stage digital readout without additional electronic or mechanical equipment. The counter provides 12-v d-c power to operate photoelectric pulsers, eliminating need for separate pulser power supply. *Datalox Div., The W. W. Henry Co.*

Circle number (13) on reply card



AXELSON-GARRETT

TYPE "C"

CIRCULATING VALVE

Full Circulating Capacity!

Unmatched for reliability, the Axelson-Garrett Type "C" Circulating Valve has now been further improved to offer all of these exclusive features: Perfect Sealing — Full Circulating Capacity — Repeatable Shifting — Positive Locating — Slim Dimensions.

Designed primarily for the displacement of well fluids, Type "C" valves may be used on permanent type completions, for selective production or for well remedial work.

When installed, the large ports in the mandrel and large annular space between sleeve and mandrel assure full capacity. The unique design and compact seals have made possible this full capacity in a valve with minimum O.D. Its characteristics make it an ideal tool for use in critical diameter parallel string completions.

When opening or closing the valve, the shifting tool automatically seats into the proper shifting position. When shifted the internal profile of the valve changes. The shifting tool can be moved only if the valve has been fully shifted, giving the operator a positive check on the position of the sleeve.

A new Brochure (#CVC) is now available showing the many services that can be performed by this valve. Illustrations include shifting and checking the valve when opening or closing. Write for your copy today, or check with your Axelson-Garrett man.

USI Axelson-Garrett

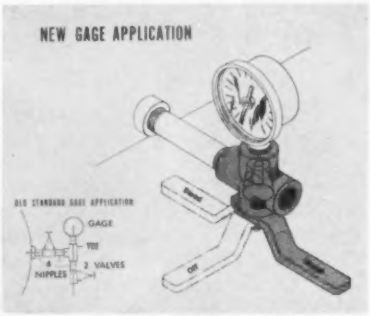
DIVISION OF U.S. INDUSTRIES, INC.

"Products Designed to Give Oil a Lift"

General Offices: Longview, Texas

Valve in Economical Gage Use

A gage application using a Tufline instrument plug valve Teflon sleeves results in considerable savings and simplified operation. It involves connecting only a factory-installed ¾-in. male adapter. Key to the application is the Tufline instrument plug valve, in ¼, ⅜ and ½-in. sizes, which provides gage cut-off, gage



bleed and calibration with single 180-deg operation. Rated for 300 psi, this valve is especially recommended for on-off use on rated pressures within temperatures from −50 F to +400 F, with gas or liquid, corrosive or non-corrosive media. Connecting the valve for gage application is easy because it has screwed ends (½-in. standard pipe thread). Gage is threaded into the end opposite the end with the wrench, and valve by means of the adapter is attached to pipe containing the liquid or gas to be measured. *Continental Manufacturing Co.*

Circle number (14) on reply card

Flow-No-Flow Reporting Device

The FS/1 sensor and S1-A control unit provide an economical and accurate flow-no-flow reporting device without mechanical impellers or vanes. The sensor has no moving parts, will withstand 3000 psi, is sensitive enough to detect flow of 2 gal per hr and is easily installed in standard tee or welded boss. Electric signal is transmitted from sensor to control unit where it is amplified and, through a transistorized circuit, energizes a relay capable of switching loads up to 5 amp. Input is 110-120 v a-c. Draw is less than ½ amp. The device is available for rack mounting, multiple installations or in explosion-proof boxes. *Flotec Corp.*

Circle number (15) on reply card

Literature

Treating Equipment Data

There are 15 individual product bulletins on the Continental Hoil line of oil emulsion treaters and testers, gas separators, free water knockouts, water filters and similar equip-

ment. Each bulletin is complete with product description, specifications, dimensions and cutaway view to show inter-workings. Also available is 4-page "family line" bulletin briefly discussing all Continental Hoil equipment. An attractive cover keeps all the bulletins together. *Continental-Emsco Co.*

Circle number (16) on reply card

Modern pH, Chlorine Control

Valuable information collected by the W. A. Taylor & Co. staff during 35 years of specialization in pH, chlorine and phosphate control and in water analysis is placed at your disposal in a 101-page book. It discusses pH control and methods for determining pH. It contains tables giving approximate pH values for a number of substances. Comparators and their operation are illustrated. *W. A. Taylor & Co.*

Circle number (17) on reply card

Caustic Soda Safety Chart

A wall chart lists safety precautions in handling anhydrous caustic soda and offers first aid instructions. It is red and black and clearly specifies the four measures that should be followed to avoid accidents when using caustic soda. *Solvay Process Div., Allied Chemical Corp.*

Circle number (18) on reply card

Booklet On LACT Units

Of interest to producers is a booklet detailing with photographs and diagrams the operation of J&L lease automatic custody transfer units, their features, specifications, standard and operation components and installation. There are stock units for immediate installation or custom-made units. *Jones & Laughlin Supply Div.*

Circle number (19) on reply card

Valve Sizing Paper

"A Practical Look at Valve Sizing" is a 4-page technical paper explaining in layman's language exactly what appears in undersized, oversized and correctly sized pressure reducing applications. It points out with illustrations dangers of missizing and advantages of correct sizing. A typical example is given. *Jordan Valve, Div. of Richards Industries Inc.*

Circle number (20) on reply card

For Rocky Mt. Air Drilling

Three new packaged air compressors offered for rent in the Rocky Mountains are described as specially designed to give "enough volume . . . enough pressure . . . enough air to drill with economy . . . regardless of the altitude of your location." A 4-page, 2-color publication says output of one unit is 1550 cfm at a discharge pressure ranging from 0 to 500 psig, 1450 cfm to 800 psig and 1180 cfm at 1250 psig. Design is based on 12 psia suction condition at 5500-ft altitude. Included is performance curve for the packaged units which were manufactured by Clark Bros. Co. *Magcobar Mud Co. Inc.*

Circle number (21) on reply card

Hammerdril Case Histories

Nearly 20 case histories from oil areas in the United States and Canada highlight a new 6-page brochure on the Mission series 350 Hammerdril which is leased to drilling contractors for fast, straight-hole, percussion air/gas drilling. The brochure includes specifications for various sizes, pictures all parts and explains principles of the tool's operation. *Mission Manufacturing Co.*

Circle number (22) on reply card

Tool Rebuilding Services

Hughes Tool Co. has issued an illustrated brochure detailing the facilities and services it now offers for rebuilding machine tools and related equipment. The recently completed 90,000-sq-ft machine tool rebuilding unit at the firm's Houston, Tex., plant is designed to serve manufacturers in a 20-state area in South and Southwest. *Hughes Tool Co.*

Circle number (23) on reply card

Ready-Reference Catalog

An extremely handy guide to perforating equipment has been issued. Easy-to-read index tabs refer you to jet perforating and logging equipment, plugs, bailers, packers, cablehead assemblies, casing collar locators, adapters and hoist units. Each piece of equipment is diagramed, with description and price of each part. *Go Perforator Supply Inc.*

Circle number (24) on reply card

Installation Case Histories

Thirty-one typical early installations of oil field pipe made from Delrin acetal resin are contained in a new booklet. Histories cover applications by both large and small producers in nine states. Included are flow, gathering, waterflood and salt water disposal lines. *E. I. Du Pont de Nemours & Co.*

Circle number (25) on reply card

NOW
MORE DRILLING INFORMATION

THE MODELS G7PW OR G7TW RECORDER

These models of the Geolograph Recorder were developed particularly for the contractors and operators desiring more detailed, recorded data concerning the four drilling variables—Rate of Penetration, Drilling Weight, Pump Pressure and Torque. This information is required to compete in today's highly competitive drilling situation.

Geologists obtain more information about rate of penetration and sub-surface formations and toolpushers are supplied with the information necessary to determine the optimum drilling rate for a particular formation.

Engineers and contractors can readily interpret the recordings of weight on bit, pump pressure (or torque), downtime, rate of penetration, tightspots and bit wear in making accurate decisions regarding existing drilling conditions.

The result: more hole per dollar.

When you drill your next well, specify the Model G7PW or G7TW Recorder. For additional information, ask for Catalog No. 220, or call your nearby Geolograph Oil Field Services office.

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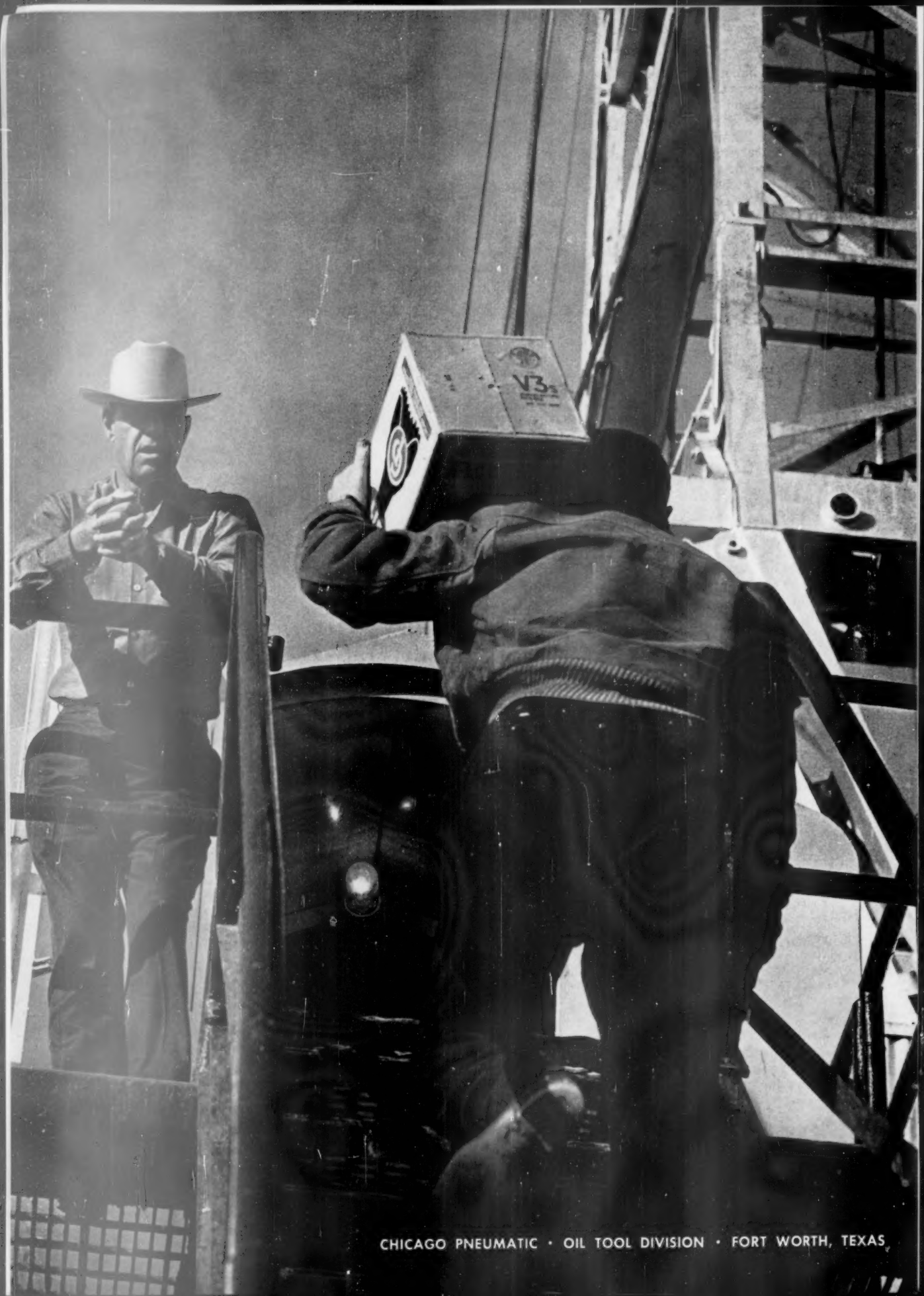

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When you specify CP Oil Tools you can be sure of top performance from our products . . . and from your CP Field Representative.

The CP Field Engineer who services your rig takes pride in *his availability* under the most difficult field conditions . . . and he takes pride in *his product* under every drilling condition.

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At CP we know that you've "no time for downtime!"

AVAILABILITY of manpower and tools is our around-the-clock responsibility . . . just as making hole is yours! Let us show you how the Cost-cutting Performance of CP in-hole tools pays off under the toughest field conditions.

Chicago Pneumatic
FORT WORTH, TEXAS

BITS • DRILL COLLARS
REAMERS • TOOL JOINTS

Suppliers' Parade

To accommodate new personnel and provide room for new integrated data processing equipment linking its Houston, Tex., office with Beaver Falls, Pa., headquarters, Babcock & Wilcox Co.'s tubular products division has relocated its Houston sales offices. New quarters are at 3015 Richmond Ave.

Continental-Emsco Co. has acquired patents, prints, manufacturing equipment, trade names, inventory and right to use the name of Hoil Engineering Corp., emulsion treating and testing firm for which Continental-Emsco has been exclusive world-wide distributor since 1959. The Continental Hoil line will be produced in Houston, Tex. Russell D. May, Hoil president, will assist in coordinating manufacture and sales of the equipment, headquartering in Dallas. Another Hoil employee, Carl Esbach, joins Continental-Emsco as shop foreman at the Houston plant. Continental-Emsco employees assigned as Hoil specialists are: D. W. Beaman, Midland, Tex.; J. P. Bowyer, Los Angeles, Calif.; O. C. Davis, Billings, Mont.; T. A. Falcon, Lafayette, La.; G. H. Middleton, Casper, Wyo.; C. E. Oxford, New Harmony, Ind.; Louis Freedman, Houston; R. E. Prowell, Shreveport, La.; and F. R. Tracy, Tulsa, Okla.

Grayloc Sales Div. of Gray Tool Co. has appointed the James E. Dyer Co., Tulsa, Okla., as representative in Oklahoma, the Texas Panhandle, lower part of Kansas and northwest corner of Arkansas.

Complete rebuilding services for machine tools and related equipment are now being offered by Hughes Tool Co. The recently completed, 90,000-sq ft machine tool rebuilding unit at Hughes' plant in Houston, Tex., is designed to serve manufacturers in a 20-state area in the South and Southwest.

Jetwell Inc., Tulsa, Okla., wireline servicing company, has opened an office at 565 First National Bldg., Oklahoma City. Jack Pouland has been moved from Wichita to be vice president in charge of sales in Oklahoma City. Wayne Harrel has been ransferred from Shawnee to Enid and promoted to district manager.

Louisiana Oilfield Rentals is a new Lafayette, La., service company specializing in welded-blade stabilizers and string reamers. The company, headed by W. R. (Bill) Angelle Jr., has established a branch office in Houston, Tex., and a stock point at Harvey, La., to provide complete service to Louisiana, South Texas and Mississippi.

Ed Flynt

Mid-Continent Supply Co. has established a warehouse and stock of merchandise in Many, La., to meet Sabine Parish needs. In charge of the new installation is Ed Flynt, formerly head floorman in Mid-Continent's Magnolia, Ark., store.

The F. H. Maloney Co. is adding about 48,000 sq ft, in two buildings, to its Houston facilities at a cost of $650,000. The new buildings will house a production line for meter provers and launchers and permit expansion of virtually all the rest of the firm's departments involved in plastics, metal and rubber product manufacturing.

Parrish Oil Tools Inc., Vernal, Utah, has been appointed Northern Utah sales representative by Oil Center Tool Co.

Reed Roller Bit Co. has acquired Livermont Inc. and Richmont Inc., both of Monrovia, Calif. Extensive patent rights for hand torque (leverage) tools and power tool torque analyzers were purchased from Liv-

ermont — and manufacturing, engineering, sales and distribution facilities from Richmont. The new Reed facility will be operated under the Cleco Div.

Maloney-Crawford Tank and Manufacturing Co., Tulsa, Okla., has reacquired Maloney-Crawford Tank and Service Co. Ltd. of Edmonton, Alta., Canada. No purchase price was announced. The Canadian subsidiary was formed in 1948 and bought by its officers four years later. There will be no personnel changes. D. L. Beattie remains as manager of manufacturing, M. A. Jackson as chief engineer, F. B. Matthews as sales manager and John Montgomery as treasurer.

Fred F. Murray is retiring as president of Oil Well Supply Div., United States Steel Corp., and is succeeded by Michael F. Hazel. Murray has been associated with the oil field machinery industry since joining Wilson-Snyder Manufacturing Corp. in 1929. When Wilson-Snyder merged with Oil Well Supply Co. Murray, then Wilson-Snyder vice president, was made "Oilwell" vice president. He was elected president in 1943. Hazel has been with Oil Well Supply since receiving his BS degree in Mechanical Engineering

F. F. Murray

M. F. Hazel

from Penn State. He has served as West Texas district sales manager, assistant division sales manager at Houston, assistant to the vice president at Dallas, assistant general manager of sales, general manager of sales, director of engineering, vice president-sales and, most recently, executive vice president.

Two new oil field distributors for Worthington Corp. industrial pumps and compressors are: Kern Electric Distributors, 415 30th St., Bakersfield, Calif.; and Mid States Armature Works, 618 N. Santa Fe St., Salina, Kan.

Appointments and Promotions

Alpha Corp. — Vernon Louis Hedges, microwave sales and engineering representative for the Microwave Systems Div., Galion, Ohio.

Bowen Itco Inc.—elected to the board of directors: Homer F. Junker, controller; and Lynn Storm, consulting petroleum engineer. Also, G. Reid Hodgson, vice president of engineering, formerly director of engineering and research; and Z. C. Ambrose, vice president of sales, formerly general sales manager.

The Colorado Fuel and Iron Corp.—W. W. Leonard, from assistant tubular sales manager to manager; and D. W. Kelly, from tubular sales engineer for the Rocky Mountain area to assistant to the manager.

Continental-Emsco Co. — Ronald Young, store manager, Daisetta, Tex., formerly D+B specialist there; Francis Krutsinger, Grayville, Ill., store manager, formerly field salesman, Salem; Charles Robison, store manager, Oklahoma City,

Forgetting for the time, the problems of our great industry and pausing to remember our many blessings, our friends and our progress, we want to wish you a very

MERRY CHRISTMAS

and our hopes for your Health, Happiness and Prosperity in the year ahead.

HERCULES TOOL COMPANY
MANUFACTURERS OF OILFIELD EQUIPMENT
GENERAL OFFICES AND PLANT • TULSA, OKLAHOMA
Export Representative Oil Field Equipment Co., Inc. 90 West Street, New York, N. Y.

NOWSCO Nitrogen Cuts Completion Cost
Job #1823

Nowsco Nitrogen Uncorks a Tough One

Pressures were erratic on this 9000 ft. test. When the contractor drilled into a high pressure gas zone, he closed all return lines to avoid a blowout. He then decided to cement the drill pipe to cope with the unexpected, excessive pressure.

With heavy fluid, the contractor "corked" down the pressure, allowing him to remove the blowout preventers and install necessary completion equipment. But the operator couldn't swab the 3" drill pipe through the valves on the tree. He called NOWSCO for help.

The NOWSCO service engineer went right to work upon arrival. In 15 minutes, he'd hooked up and was pressurizing the tree with Nitrogen to its maximum limit. His plan, well-proven in the field, was to push fluid down into formation, overflush to dissolve in the Nitrogen, then release pressure. Nitrogen bubbles coming out of solution would then push the fluid up and out. Now came a hitch . . . the pressure, as limited by the tree, scarcely budged the fluid! After 3 hours, only 300-400 feet of hole had been displaced. The NOWSCO man knew from past experience that the fluid would come up if it were rocked by quick-releasing the Nitrogen pressure. This was done. With a whoosh and a gurgle, up came the "fluid"—11 lb. mud! Once started, bottom pressure pushed all of it up, bringing in a good gas well. Time—4 hours. Total cost for NOWSCO service—$250!

Savings were considerable, considering the alternative of running in a tubing string, circulating heavy mud, replacing with a larger diameter tree and swabbing out . . . not to mention the possibility of swab loss, plus several days of lost production.

Call in NOWSCO for your tough ones—when acidizing and fracturing tubingless completions, gas drilling near pay zones, combatting lost circulation. And there's a host of just plain money-saving ways to utilize NOWSCO Nitrogen in drilling, testing, displacing, acidizing, fracturing, and purging. Pressures up to 10,000 psi are available.

NOWSCO service trucks and trained operators who are oil field veterans are stationed on round-the-clock call at Houston, Corpus Christi, Odessa, Orange, Longview and Victoria in Texas, and Lafayette, La. Other stations will be opened soon in Monroe and New Orleans in La., and in Jackson, Miss.

For more information, write or call today

Originator and prime authority on liquid nitrogen techniques . . .

NOWSCO N_2

NITROGEN OIL WELL SERVICE COMPANY

3602 West 11th Street, Houston, Texas. Tel: UN 4-0965 or UN 4-7701

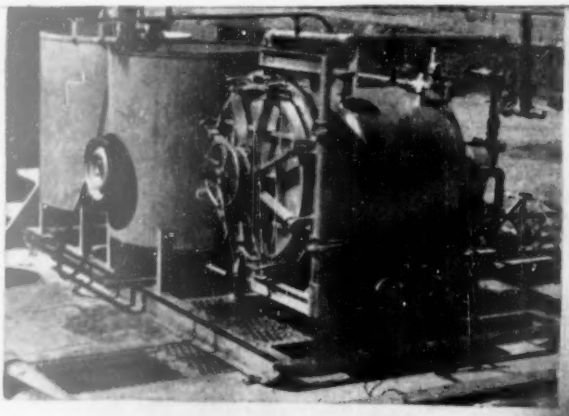
Injection water filtration

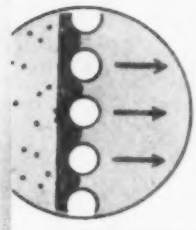
Inject water faster, keep back-pressure low with Celite Portable Filtration

Don't use inefficient, over-sized filter units to handle injection water. Now you can get fast, clean repressurizing water flow with a portable Celite® filtering system that is one-tenth the size of old-fashioned units with the same capacity. This compact unit can be mounted on skids for quick, easy installation and relocation.

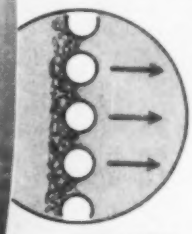
Celite diatomite filter aids remove oil, amoebae, algae and bacteria from injection water. By eliminating pore-clogging suspended solids, pumping pressure and costs are kept low and oil recovery kept high. Data from a 10,000-barrel-a-day installation show that Celite, as compared to sand, reduced hold-up time from four hours to only 30 minutes. What's more, additional reports show backwash water requirements can be reduced up to 90%.

A complete line of standard and special Celite grades is available to meet every need. For full details on how Celite assures the best quality filtration at the lowest cost, send for Technical Bulletin FF-78. Write Johns-Manville, Box 14, New York 16, N. Y.

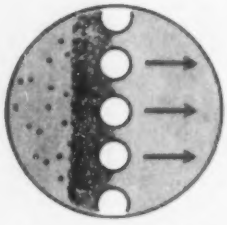




WITHOUT CELITE, fine suspended solids form a clogging seal over filter openings.



WITH CELITE, a porous cake with microscopic channels becomes the real filter surface.



DURING FILTRATION, continuous bodyfeed of Celite builds up fresh filter surfaces, greatly extending cycle life.

JOHNS-MANVILLE

JM

Okla., formerly sales representative there; Jim Barnett, store manager, Poteau, Okla., formerly field salesman, Seminole; Bert Barrow, Russell, Kan., store manager, formerly field salesman, Liberal; John Allewell, store manager, Fort St. John, B.C., formerly field salesman there; David Knotts, Magnolia, Ark., store manager, formerly field salesman there; James Anderson, store manager, transferred from Russell, Kan., to Indianola, Neb.; Jack Gum, D+B specialist, Long Beach, Calif., formerly field salesman there; Melvin Stewart and Richard Lovell, D+B specialists, formerly field salesmen, Taft, Calif.; Kenneth Buckles, D+B specialist, Henderson, Ky., formerly field salesman there; and Gary Stegall, D+B specialist, transferred from Amarillo, Tex., to Pampa.

Fairbanks, Morse & Co.—Frank C. DiLuzio, vice president, engineering, for the Beloit Group which comprises Fairbanks, Morse & Co.'s development, production and distribution of diesel engines, magneto and engine accessories, compressors, large hydraulic equipment, large electrical equipment and desalting systems. DiLuzio was an Atomic Energy Commission executive in New Mexico before joining the firm.

Geolograph Oil Field Services—Edward L. Ross, general sales manager, formerly manager of district offices in Grand Junction and Sterling, Colo.

Grove Valve and Regulator Co.—Robert C. Hensley, sales engineer at Odessa, Tex., office.

Jones & Laughlin Supply Div.—Thomas L. Webb, manager, advertising and marketing research at Tulsa, Okla., formerly in general products and tubular products sales section, Tulsa; William J. Whatley, regional manager central region, new headquarters in Oklahoma City, Okla., formerly city sales manager, Oklahoma City; and Donald R. Williams, city sales manager in charge of Tulsa sales office.

Lunkenheimer Co.—John L. Rice, sales representative in West Texas and New Mexico, formerly with the Walworth Co.

Magnet Cove Barium Corp.—R. B. (Buddy) Hyde Jr., assistant manager of the Magcobar Pacific Coast region of the marketing division,

Ball

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Bottom-Hole
Pressure Gauge

Dependability of Product Ball Brothers' Pressure Sentry MK-7, for pumping, flowing, or shut-in wells, is permanently installed below the pump. Digital signals from a Bourdon tube-coded wheel assembly are sent up a single conductor wire to assure a ± 1% pressure readout accuracy. Readout is not influenced by absolute value of current or resistance of wire. A simple, portable surface unit makes a permanent record of reservoir pressures on chart paper.

Continuous, intermittent, or automatically timed pressure recordings may be made. Available in pressure ranges to 8000 psi. Will operate in wells with temperatures to 275°F.

and Service Simple to install and operate. However, engineering, installation and repair services are always available from Ball Brothers.

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Department 101
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A Subsidiary of Ball Brothers Company, Inc.

formerly assistant to the vice president in the marketing division; John W. Puryear, personnel manager, formerly supervisor of inventory control.

H. S. Barksdale

T. E. Duhon

Mission Manufacturing Co.—Truby E. Duhon, sales representative, Louisiana Gulf Coast territory, formerly with the Louisiana branch of Tretolite Co.; and Howard S. Barksdale, sales representative, Texas Gulf Coast area, formerly division special sales representative and field engineer for a major oil field equipment manufacturer.

National Supply Div., Armco Steel Corp.—J. Ford Stuart, assistant manager of stores for the New Orleans, La., area, formerly supervisor, merchandising, there; Lewis F. Leeper, store manager, Nocona, Tex., formerly field salesman for that store; Ben A. Jackson, representative, Houston, Tex., plant; and Glenn E. Stewart, formerly field salesman, Bay City, Tex., succeeding Jackson as wellhead sales representative, Shreveport, La.

National Tube Div., United States Steel Corp.—William C. French Jr., vice president, sales, formerly general manager, sales.

W. C. Norris Div., Dover Corp.—Paul W. Colvard, assistant manager, West Texas sales division, Odessa, Tex.

Oil Well Supply Div., United States Steel Corp.—Charles H. Stewart, manager, Garland, Tex., works, formerly manager, Wilson-Snyder works, Braddock, Pa.; J. M. Haynes, product manager, Wilson-Snyder process pumps, Dallas, Tex., formerly product manager, engine and compressor sales; Dwight S. Kientz, field representative, Pettus, Tex.; James H. Renfro Jr., district representative, and Francis J. Miller, field representative, Soldatna, Alaska; R. C. Craig, Rocky Mountain area manager of tubular sales.

Orbit Valve Co.—sales representatives: S. E. (Woody) Yandle, New Orleans, La.; William S. (Pete) Peatross, Beaumont, Tex.; and D. H. (Daniel) Boone, Corpus Christi, Tex.

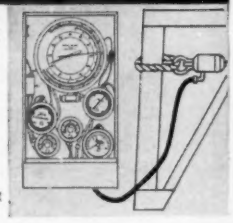
Parkersburg-Aetna Corp.—Jess Kern, manager of the newly-formed Parkersburg Pumping Unit and Brake Div., headquartered in Coffeyville, Kan.; and Willi Stahl, chief engineer, the post formerly held by Williams.

Reed Roller Bit Co.—W. F. Cannon, executive assistant to the executive vice president, in which position he will serve as general manager of the firm's Green Shade division. He formerly was personnel director.

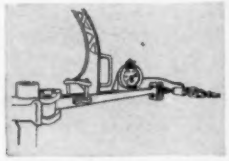
Servco Co.—Roy Baker, manager, Houston, Tex., district, formerly in charge of the Corpus Christi area; Milton A. Grappe, Corpus Christi area representative, formerly representative there for Gulf Coast Machine & Supply Co.; Sam Sutton, independent contractor, formerly associated with A-1 Bit and Tool Co. and A-Z International Tool Co.

TONG TORQUE

THE MARTIN-DECKER TONG TORQUE ASSEMBLY FOR ALL CONNECTIONS



PERMANENT INSTALLATION The cylinder attached to the back-up line provides torque indication each time collars are run.



ONE GAUGE for torque measurements of all size drill collars, drill pipe, tubing and casing.

ACCURATE AND RELIABLE readings with calibration checks seldom required.

CARE AND MAINTENANCE can be capably done by the drilling crews.

PORTABLE INSTALLATION The torque assembly attached to the tong itself can be used for spot checks on two or more rigs.

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World's principal manufacturer of Oil Well Drilling Instrumentation

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ANTI-SEIZE COMPOUND

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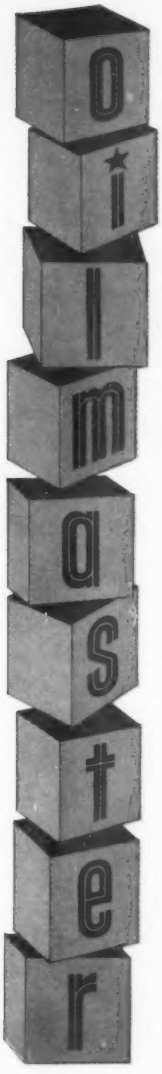

building block SIMPLICITY

a new concept in **WELLHEAD CONTROLS** for hydraulic **FREE PUMPS**

...to extend the versatility of this unique pumping system. The free pump, which substantially reduces well pulling costs, can now be safely retrieved—**unattended.** The Oilmaster Wellhead Control is safety engineered to stand guard during the pump-out operation, securely latch the surfaced unit and then bypass the circulating fluid. The pumper can remove the surfaced unit from the wellhead at his convenience.

CHOOSE THE "BUILDING BLOCKS"
—to fill your individual well requirements. Only the Oilmaster Wellhead Control provides this economy with maximum safety, flexibility and simplicity.

FAST, SHOCK-FREE SWITCHING
of flow direction is designed-in through use of independent double seated valves. Dependable operation with minimum maintenance cost is assured by replaceable stainless steel valve seats and stems and pressure actuated teflon stem packing. The control block is free swiveling to ease installation at the well.

FILL YOUR NEEDS WITH THESE OPTIONALS
- **Catcher Assembly**—Regular or Indicating
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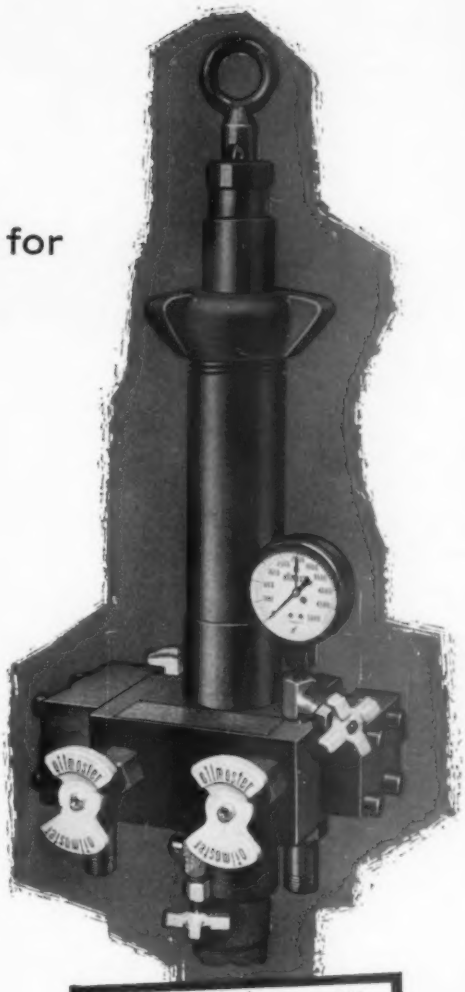
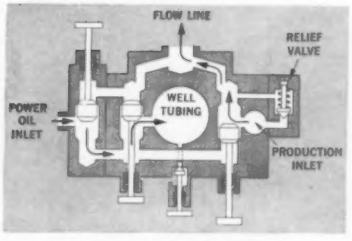
- **Power Oil Inlet**—Regular or Bypass
- **Relief Valve**—Shear Disc or Automatic Reset
- **Production Inlet**—Casing Free or Slip Joint Union
- **Lubricator**

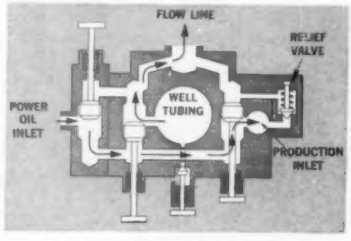
These optional "building blocks" give you the economic, safe flexibility to meet your specific Free Pump Wellhead Control requirements and your budget. **Complete details are available in Bulletin 6102.**



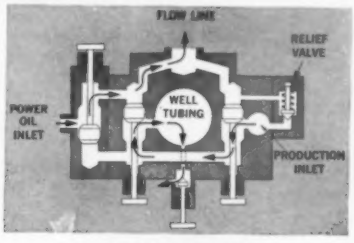
for the full story on Oilmaster Hydraulic Pumping Systems, see your local Oilmaster or distributor representative or write Fluid Packed Pump, Armco Steel Corporation, 9100 S. Norwalk Blvd., Los Nietos, Calif.



PUMP IN & OPERATE



PUMP OUT



BY-PASS & BLEED

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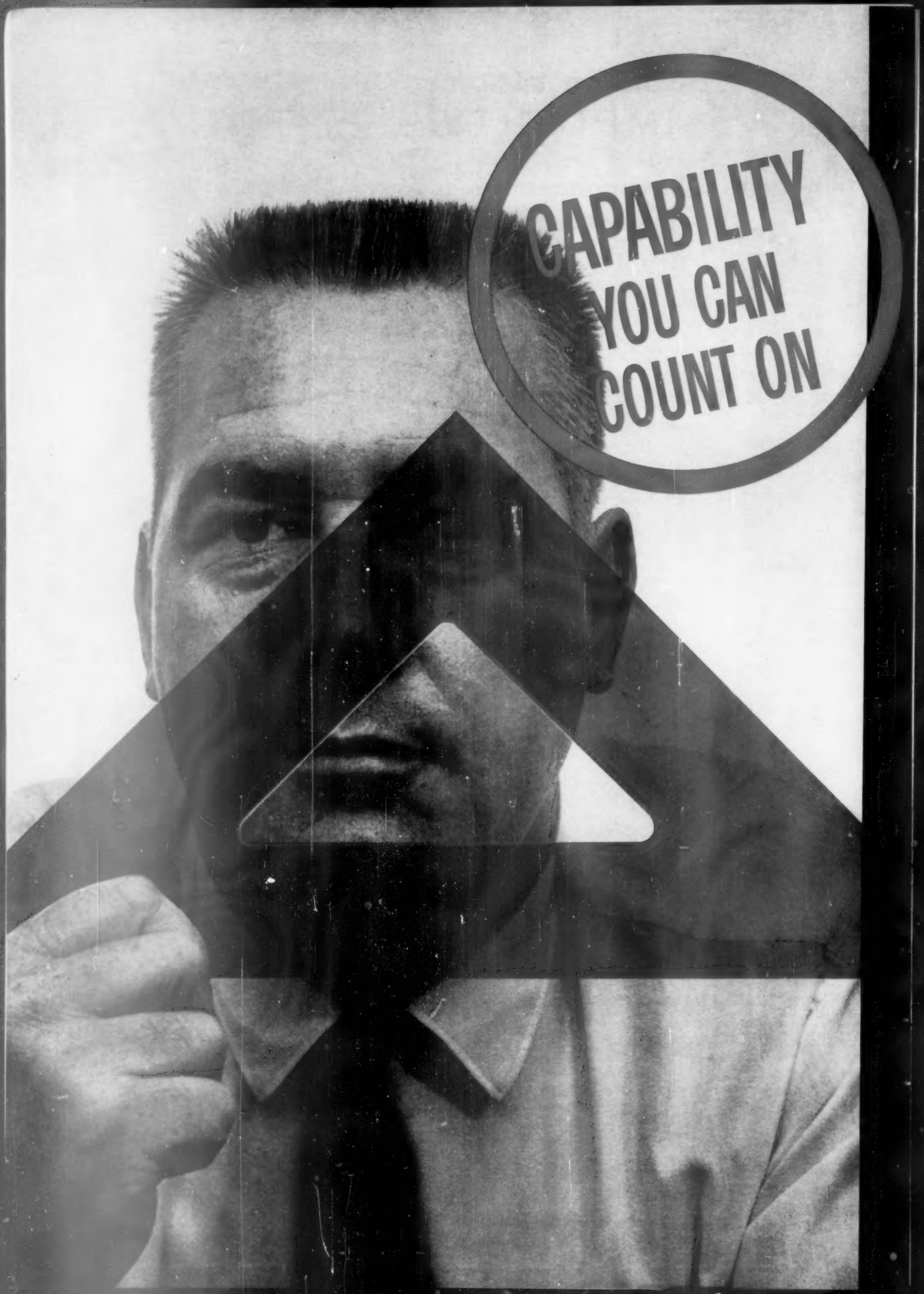
ARMCO Fluid Packed Pump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As a fully integrated manufacturer and supplier, Continental-Emsco's equipment capability extends far beyond better engineering and design! Continental maintains a highly trained field force to aid engineering in developing equipment with higher efficiency, through extensive field checks. This total responsibility means even better products for you . . faster and at lower cost! Continental's experience, resources and men add up to CAPABILITY you can count on . . worldwide!

CONTINENTAL EMSCO

CONTINENTAL EMSCO COMPANY, a Division of The Youngstown Sheet and Tube Company
General Offices: Dallas, Texas
Export Office: New York, New York

C 31-31

Lee Thomas

Supply Center Inc.—Lee Thomas, Northern Rocky Mountain representative, 6559 W. 66th Ave., Arvada, Colo., formerly domestic sales manager of Eastman Oil Well Survey. Supply Center was recently named Four Corners area representative for Grant Oil Tool Co. and C. W. Cotton Supply Co.

The Youngstown Sheet and Tube Co.—Robert E. Williams, vice president, sales, succeeding Myron H. Watkins who has resigned after 36 years with the company. Williams previously was vice president, sales, National Tube Div., United States Steel Corp.

Tube-Kote Inc., Tuboscope Co.—B. J. Ramey, general marketing manager, formerly with Western Geophysical Co.

Thornhill-Craver Co.—sales representatives: for Louisiana, H. O. (Jack) Duncan, formerly with Houston Oilfield Material Co. and Louisiana Supply, who will headquarter in Lafayette; and for Arkansas, North Louisiana and Mississippi, James B. Wilkerson, formerly with Black, Sivalls and Bryson, who will headquarter in Shreveport.

Tretolite Co.—O. L. Bassham, assistant division manager, Corpus Christi, Texas Gulf Coast district, formerly assistant general manager, Lafayette, South Louisiana district; R. R. Sigler, succeeding Bassham at Lafayette, formerly service engineer at El Campo, Tex.; and C. F. Griffin, replacing Sigler at El Campo, formerly with Wilson Supply Co.

Welex—George Harcourt, director of the firm's "new customer program", formerly Dallas area sales manager in which he is succeeded by Weldon Porter who also is chief completion services engineer.

New Research Laboratory for Baker Oil Tools

The new Houston engineering and research laboratory of Baker Oil Tools, Inc. has been opened for business. The new 9000-sq ft structure, erected on the site of the company's Houston manufacturing plant, includes a completely equipped 1000-ft test well, three hot test cells, pressure equipment test fixtures, recording and measuring apparatus.

W. S. Althouse, top engineering executive, commented that "our combined Houston and Los Angeles testing facilities now enable us to conduct hot tests up to 550 F. With completion of our new Houston laboratory, we will soon be able to conduct tests at temperatures in the vicinity of 1000 F under pressures in excess of 20,000 psi!"

Establishment of this modern laboratory follows the transfer of the company's entire research engineering department to Houston in 1959. Research chief H. H. Fisher indicated that "even though the lab isn't as yet completely equipped, the research department staff has already programmed a full schedule of testing that will result in development of new and improved products in the very near future."

J. D. Keithahn, chief product engineer, commented on the safety features of the laboratory. "When you're testing packers and squeeze tools at the temperatures and pressures required these days, protection of personnel is paramount. The entire windowless structure, test cell design and location, use of remote control for actuating and measuring apparatus make this lab one of the safest and most efficient anywhere."

Exploration

ARKANSAS

A new oil pool in the Lapile area of southern Union County was indicated by one of 17 completions recently reported to the Arkansas Oil & Gas Commission. The indicated discovery was George Parker and Crow Drilling Co.'s No. 1 Phifer, SE SW 17-18s-11w, which recovered some oil after drilling to 6144 ft at the venture southeast of the old New London Pool.

CALIFORNIA

California's largest known oil reserve, located in the offshore area of Long Beach, may be tapped next year as a result of a 10-months study made by harbor engineers. An estimated 797 million bbl of oil and 163 billion cu ft of gas have not been developed due to a Long Beach antidrilling ordinance designed to eliminate severe subsidence problems in the area. Voters would have to lift this drilling ban before work could begin.

The engineers' report recommends that development of the area be accomplished from four 10-acre drilling islands located offshore. All parcels would be produced under a carefully controlled program of pressure maintenance to prevent subsidence and effect maximum economic recovery of oil and gas.

CANADA

Drilling for Arctic oil has started on Melville Island, 1550 miles north of Edmonton, Alberta. The drill is expected to be down about 10,000 ft by late December. A half dozen wells may be drilled before oil is found. Canadian, United States and British firms having interest in the area include Dome Petroleum, California Standard, Canada Southern Petroleum, Clark Oil & Refining, Round Valley Oil, Tidewater Oil and Union Oil of Canada.

The California Standard Co., subsidiary of Standard Oil Co. of California, has discovered a new oil field in the Beaver Hill Lake formation of the Upper Devonian, five miles east of the eastern limits of the Kaybob field in Alberta. The discovery well, Pacific-Calstan-B.A. Kaybob 10-4-64-18 flowed 45.5 deg oil at a daily rate of 400 bbl from a test interval of 9606-96 ft. The well is a joint venture of three equal partners, California Standard, Pacific Petroleum, Ltd., and British American Oil Co., Ltd.

COLOMBIA

Colombia Petroleum Co., jointly owned by Texas Petroleum and Mobil Oil, struck oil in a well on Mompos Island, Bolivar Province. The new well is expected to flow about 1000 bpd when placed on production.

EAST AFRICA

Drilling of a deep test well on Pemba Island off the East African coast is planned. Pemba Island, a part of the Zanzibar Protectorate, is opposite the border between Kenya and Tanganyika. BP-Shell Petroleum Development Co. will drill the well. In Kenya, the fourth and last of a series of stratigraphic wells is being drilled at Mararani, some 20 miles from the coast and the Somali border. The third well of this series, Meri No. 1, was completed to a depth of 6300 ft. A geophysical party has been operating in East Africa this year; first in the Pandangua area of Kenya, then on Pemba, and currently in the Puga area of Tanganyika.

KANSAS

Discovery of a new oil field in Pratt County, about 3 miles south of the city of Pratt, was announced by Continental Oil Co. On a production test, the J. Brehm Well No. 1 in the East Heartlein area flowed at a daily rate of 205 bbl of 33-deg oil and no water from perforations at 4422 to 4433 ft on an 8/64-in. choke. Total depth of well was 5577 ft. Conoco has a block of 1600 net acres in the area. Nearest production is 9 miles east in the Chitwood field.

LOUISIANA

A new oil field in the West Timbalier Bay area of LaFourche Parish, south Louisiana, has been discovered by Union Oil Co. of California. The find is located midway between the Caillou Island and Timbalier Bay fields where Union is already producing. The discovery well, Union-LL&E 3088 No. 4, encountered multiple oil and gas bearing sands in the interval from 11,250 ft to bottom at 14,208 ft. It was completed in an oil zone flowing 280 bpd of 35.1 gravity crude through a 9/64-in. choke with 1390 lb tubing pressure. Perforations are from 11,252 to 11,257 ft. Deeper pays, including an oil zone tested at 110 bbl per day and a 73-ft gas-condensate zone, will remain behind pipe for completion and production at a future date.

Atlantic Refining Co. has discovered what appears to be major natural gas reserves in the lower Miocene geological formation of the Jenerette field in St. Mary Parish. A recent test of the discovery well, J. R. Roane No. 2, produced at the rate of 9½ MMcfd of gas through a ⅜-in. choke.

Van Dyke & Mejlaender have staked location for a 11,000-ft wildcat in Plaquemines Parish in the south Louisiana area. The company's No. 1 Cherokee, Inc. is 5 miles northeast of LaFitte field and a mile east of the Mississippi River. The test spots 1100 ft from the north line and 660 ft from the east line of Section 39, T-16S, R-13E, on a 3000 acre block partially acquired by farmout from Pan American Petroleum Corp.

NEBRASKA

First swab gaged 8 bbl per hr from the Edwin Foster Blair and Murfin Drilling Co. No. 1 Schneider, C NE NW 5-5n-30w, Frontier County, of the Cambridge Arch of southwestern Nebraska. Oil came from the Cherokee limestone from acidized perforations at 4242-51 ft

after drilling to 4370 ft. Initial drillstem test recovered 525 ft of oil in 60 min from 4247-70 ft. This discovery is about a mile southwest of the Spring Creek Pool discovery well, so far the only producer in Frontier County.

NEW MEXICO

Drilling & Exploration Co., Inc., has completed an oil discovery well on a 7520-acre Federal Unit in Lea County in southeastern New Mexico. The well, Mescalero Ridge Unit No. 1, flowed at a rate of 523 bpd of 38 gravity crude oil on a 12-hr test through a ¼-in. opening. Production is from perforations between 10,188 and 10,134 ft in the Bone Springs section of the Permian Formation. An indicated natural gas discovery was also made from openings between 13,328 and 13,340 ft in the Pennsylvanian formation.

OKLAHOMA

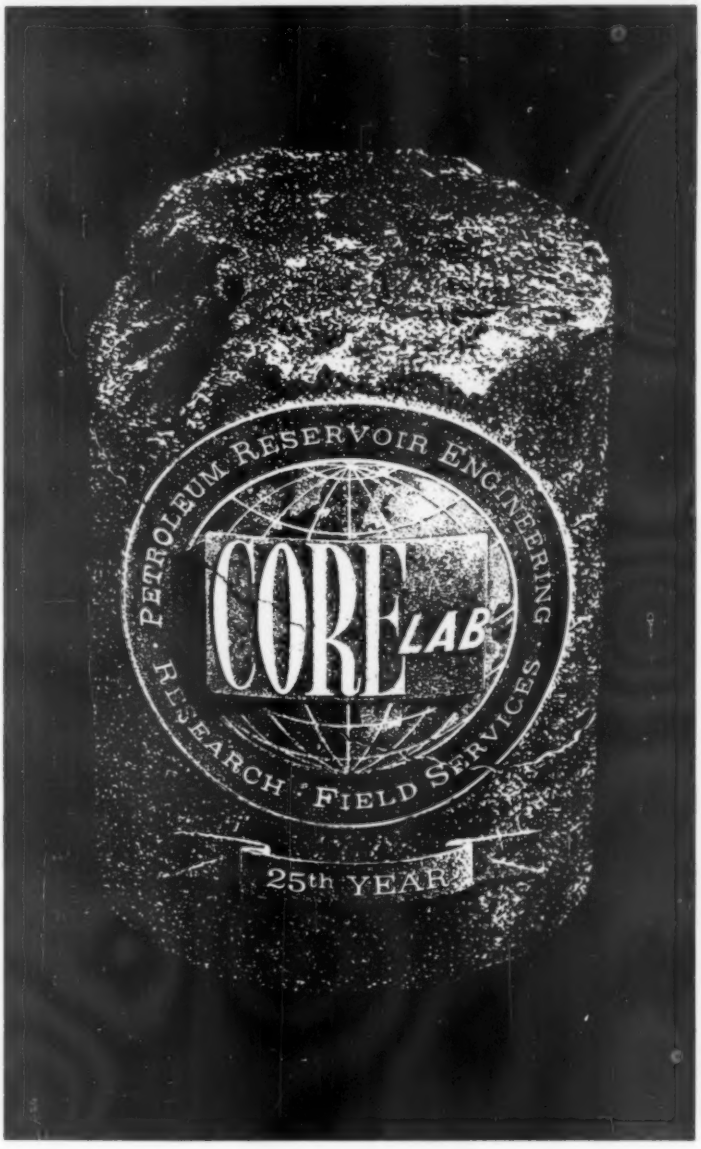
Continental Oil Co. completed No. 1 Hobbs, C SE SE 22-19n-7w, in the Southwest Hennessey Pool as a two-zone producer. Perforations in the Manning at 6815-29 ft flowed 114 bbl of oil in 6 hr on an 18/64-in. choke with 473,000 cu ft of gas daily. The Meramec open hole at 7045-135 yielded 143 bbl of crude in 4 hr on a 20/64-in. choke.

Humble Oil & Refining Co. has dually completed the No. 2 Hunton-Aldrich, NE NE 34-19n-7w, producing 148 bbl of 35.4 gravity oil in 6 hr on a 24/64-in. choke from Manning perforations at 6833-68 ft. Meramec open hole at 7079-225 ft flowed 138 bbl of 37 gravity oil in 17 hr on a 20/64-in. choke. Total depth was 7255 with two strings of 2⅞-in. casing set at 7077 and 7079 ft.

A 4-hr flow test from Kent T. Kimbal's discovery well in the Lincreek field of western Creek County yielded 100 bbl an hour from the Arbuckle Lime Zone with no diminishing of strong pressure. The well is No. 1 Williams, SE SE SW 6-15n-7e. Flow through small openings at 4040-65 ft was 28.6 deg gravity crude.

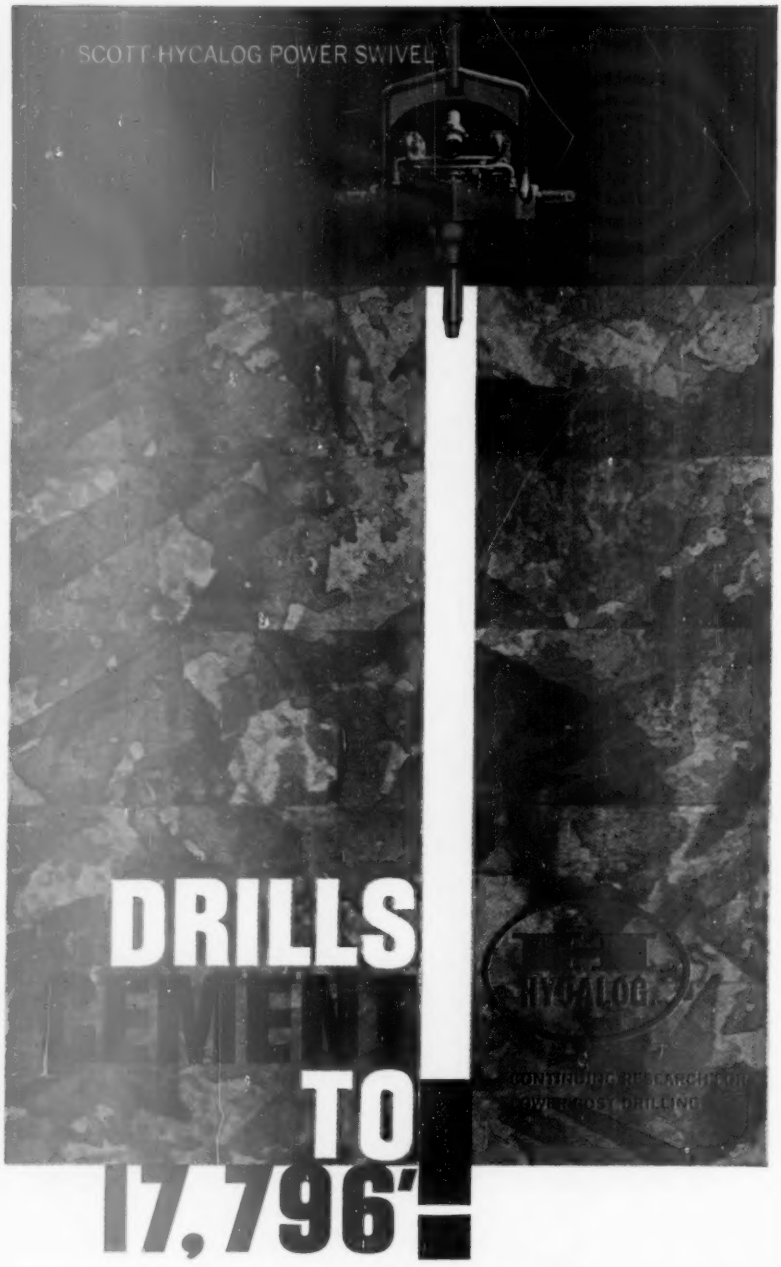
TAIWAN

Asiatic American Inc. of Oklahoma City, Okla., will prospect for oil on this Nationalist China island. Any oil found in commercial quantities will be bought by Chinese Petroleum Co., Kaosiung, Taiwan, from the prospecting company. Thus far, oil has been found at



Pacemaker for twenty-five years of petroleum reservoir engineering services . . . And as we pass the quarter-century mark, more people in more places are using more Core Lab data than ever before.

UNITED STATES CANADA SOUTH AMERICA EUROPE AFRICA



NO KELLY OR ROTARY was needed for drilling cement and milling in this Washita County, Oklahoma well. Beginning at 14,300' in 3½" casing a center cut mill on 2" drill pipe was rotated with the power swivel at operating torque of 9920 in. lbs., hook load of 85,000 lbs. and circulating pressure up to 5000 lbs. Drilling rate was controlled to 10 ft. per hr., due to reduced circulation rate. ■ Ask your Hycalog rep how a Scott-Hycalog swivel can save money on your next drilling or workover program.

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DIAMOND BITS CORE BARRELS WELL LOGGING CORE ANALYSIS

three places near Miaoli in the north central part of the island, but Chinese Petroleum Co. derricks have produced only about 60-70 bbl daily. The wells, however, are producing natural gas being used in Taiwan's chemical fertilizer plants.

TEXAS

Pan American Petroleum Co. has made a Smackover lime discovery for Van Zandt County in East Texas. The company's No. 1 J. H. Parker, in William Hart survey, A-342, rated an open flow of 19.6 MMcfd of gas plus 133 bbl of 55.9 gravity condensate per million from perforations at 12,834-900 ft.

Production tests have been made by Humble Oil & Refining Co. at No. 3 E. A. Wendlandt, in Jose M. Acosta survey, A-1, a Paluxy prospector on the Brooks Salt Dome in Smith County. A 1-hr drillstem test at 8025-45 recovered 1565 ft of 28 gravity oil.

One of the largest natural gas discoveries ever recorded in the Permian Basin was made by Holland Oil Co., San Antonio. The discovery well, No. 1 Marion Hayes, is in Concho County, 4½ miles southeast of Paint Rock. A test produced gas at a rate of 350 MMcfd from perforations between 3376 and 3386 ft deep.

Another gas field for the Texas Panhandle field has been discovered by Pan American Petroleum Corp. The company's No. 1 Beck Unit "C", C SW NW 86-10-HT&B survey, 6 miles northeast of Follett townsite in Lipscomb County tested for a 24-hr completion potential of 20 MMcfd of gas with a shutin tubing pressure of 2500 lb. Openings were made at 728, 836 ft in the Morrow formation. Hole was drilled to 9200 ft and backed up.

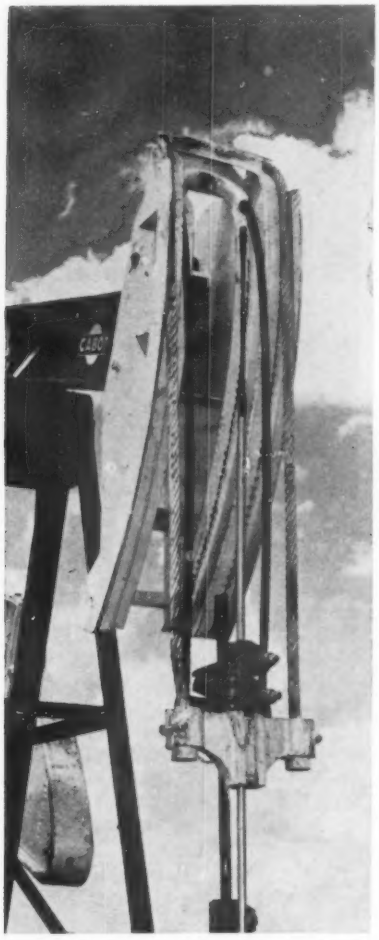
Making oil at three of four zones that Texaco Inc. has found at a 1½-mile southeast extension to Devonian and Ellenburger production in the Andrews Pool of Andrews County, has given the West Texas field a triple producer. The latest zone to yield a potential test was the Pennsylvanian. It flowed 165.84 bbl of 38.6-gravity oil, plus 4% water, through 20/64-in. choke from openings at 9022-94 ft after treating with acid. Gas-oil ratio was 428-1. Earlier flows were from the Ellenburger at 12,457-77 ft and from the Wolf-camp at 8609-18 ft.

Dual Horsehead Pumps Two Zones

Olin Oil & Gas Corp. has installed this unique horsehead assembly on its Kunkel No. 1 well near Castle, Oklahoma. Utilizing a single pumping unit, the dual horsehead with its two wireline hanger assemblies permits the well's two producing zones to be pumped simultaneously.

Oil strings for both zones were run inside 5½-in. casing. The deeper zone, at 3750 ft, is produced through 2⅜-in. tubing with a 1½-in. bore pump and ⅝-in. sucker rods. The shallow zone, at 3200 ft, is produced through 1¼-in. macaroni tubing with an integral joint, using a ⅞-in. bore pump and ½-in. rods.

The pumping unit and special head were designed and manufactured by Cabot Corp.



A specially designed horsehead which permits a single pumping unit to produce two oil zones using two separate oil strings, has been placed in operation by Olin Oil & Gas Corp. on its Kunkel No. 1 well near Castle, Okla.

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What's doing in Drilling

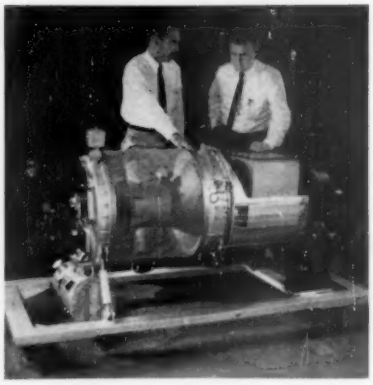
250,000 Wells!

A recent 5-year analysis by the Independent Petroleum Association of America reported that U. S. daily productive capacity increased by a million barrels when the industry drilled more than 250,000 wells and spent more than $30 billion to find, develop and produce oil.

Turbine Drives Rotary Rig

Industry's efforts for the past three or four years to harness the light-weight power inherent in turbines for rig drives is coming closer to reality. A field test is now underway on a new industrial turbine developed by General Electric from its aircraft experience. It is a multiple-fuel, 500-hp turboshaft engine coupled to a direct current generator to supply power for electric rig drives. The turbine-generator package is skid mounted.

Designated the LM50 model, this first multiple fuel turbine for rig power will go to Helmerich & Payne, Inc., of Tulsa, Oklahoma,



for field tests on Rig 52 operating in West Texas. The 1000-lb turbine (2 lb per rated hp) is a simple cycle, two-shaft gas turbine capable of operating on various liquid fuels or natural gas.

Major engine components are a gas generator, which consists of a compressor, combustor and turbine, and an aft-mounted power turbine that harnesses the energy in the exhaust from the gas generator section, converting it into mechanical horsepower. The compressor consists of three axial stages and one centrifugal stage, driven by a single-stage turbine. The power turbine, also single stage, transmits power to the output shaft through two steps of gear reduction. It may be operated at either a fixed power turbine speed, or over variable speed ranges.

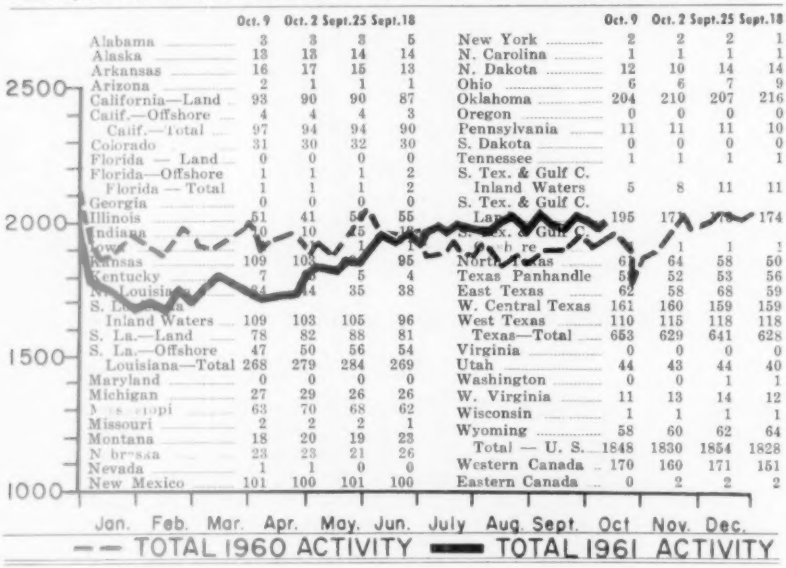
Clements Elected Pres. AAODC

John J. Moran, left, of Moran Brothers, Inc., Wichita Falls, Tex., passes the gavel as president of American Association of Oilwell Drilling Contractors to William P. Clements Jr., president of Southeastern Drilling Corp., Dallas. Other officers are: Warren L. Baker, executive vice president; Charles H. Todd, R. W. Rine Drilling Co., Wichita, Kansas, national vice president; E. Dale Mount, president, Dale Mount Drilling Co., Dallas, secretary-treasurer; and Joseph M. Shelton, Dallas, general counsel.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oil Well Contractors by Hughes Tool Company

	Oct. 9	Oct. 2	Sept.25	Sept.18
Alabama	3	3	3	5
Alaska	13	13	14	14
Arkansas	16	17	15	13
Arizona	2	1	1	1
California—Land	93	90	90	87
Calif.—Offshore	4	4	4	3
Calif.—Total	97	94	94	90
Colorado	31	30	32	30
Florida — Land	0	0	0	0
Florida—Offshore	1	1	1	2
Florida — Total	1	1	1	2
Georgia	0	0	0	0
Illinois	51	41	54	55
Indiana	10	10	15	13
Iowa	1	1	1	1
Kansas	109	103	103	95
Kentucky	7	6	5	4
N. Louisiana	34	34	35	38
S. Louisiana				
Inland Waters	109	103	105	96
S. La.—Land	78	82	88	81
S. La.—Offshore	47	50	56	54
Louisiana—Total	268	279	284	269
Maryland	0	0	0	0
Michigan	27	29	26	26
Mississippi	63	70	68	62
Missouri	2	2	2	1
Montana	18	20	19	23
Nebraska	23	23	21	26
Nevada	1	1	0	0
New Mexico	101	100	101	100
New York	2	2	2	1
N. Carolina	1	1	1	1
N. Dakota	12	10	14	14
Ohio	6	6	7	9
Oklahoma	204	210	207	216
Oregon	0	0	0	0
Pennsylvania	11	11	11	10
S. Dakota	0	0	0	0
Tennessee	1	1	1	1
S. Tex. & Gulf C.				
Inland Waters	5	8	11	11
S. Tex. & Gulf C.				
Land	195	171	170	174
S. Tex. & Gulf C.				
Offshore	1	1	1	1
North Texas	61	64	58	50
Texas Panhandle	51	52	53	56
East Texas	62	58	68	59
W. Central Texas	161	160	159	159
West Texas	110	115	118	118
Texas—Total	653	629	641	628
Virginia	0	0	0	0
Utah	44	43	44	40
Washington	0	0	1	1
W. Virginia	11	13	14	12
Wisconsin	1	1	1	1
Wyoming	58	60	62	64
Total — U. S.	1848	1830	1854	1828
Western Canada	170	160	171	151
Eastern Canada	0	2	2	2



West Canada Drilling Highest in 1960

The first complete survey by the Canadian Petroleum Association of expenditures by all companies in Western Canada indicate a high rate last year, only exceeded by

1957 when total expenditures rose to $622 million. Total in 1960 was $619 million.

Drilling accounted for a lion's share in both years, although drilling costs last year were higher than in 1957. Total spent on drilling in Western Canada in 1960 totalled $186 million, when $70 million was spent for exploratory drilling and $116 million on development drilling.

In the high year of 1957, only $65 million was spent on exploratory drilling and $119 million on development drilling, for a total of $184 million.

Survey period covered is from 1947 through 1960. Alberta leads other provinces, representing in excess of three-fourths of all expenditures. 1961 is expected to be another high year due to active rate of natural gas development.

Proposed Bit Wear Code

A code of drilling bit condition has been recommended for adoption by the AAODC and for use on bit records. The proposed code was worked out by a special study committee on bit wear working inside the Weight/Speed/Penetration Committee, of AAODC and headed by Jack Knowlton of Martin Decker Corp., Long Beach, Calif. The code, which is similar to that endorsed by the Canadian Drilling Contractors Association, is in three categories as follows:

Tooth Dullness
(general examination):
T1 ..... tooth height 1/4 gone
T2 ..... tooth height 1/2 gone
T3 ..... tooth height 3/4 gone
T4 ..... tooth height 4/4 gone
(Note: If any *one* row has a majority of the teeth broken, add the letters "BT").

Bearing Condition
(check the worst cone)
B1 ..... tight
B2 ..... medium
B3 ..... loose
B4 ..... locked or gone

Bit Gage
I ..... in gage
O ..... out of gage
(Note: if out of gage, follow the "O" with the amount out of gage in fractions of inches).

As an example, if the bit wear code is T1 - B2 - I, condition of the bit is as follows: teeth ¼ gone, bearing medium, bit in gage; Or, if bit wear code is T3 - BT - B3 - O½, it means: teeth ¾ gone, broken teeth, bearing loose and bit out of gage ½ in.

Contractors in the News

George L. Cutsinger, formerly in charge of mud programs and contract negotiations for Brantly Drilling Co. of Midland, Tex., was recently named vice president in charge of domestic drilling operations.

Kerr-McGee Oil Industries, Inc., of Oklahoma City, announced recently four important organizational changes. J. Norman Baxendale, formerly regional drilling superintendent of the Mid-Continent and Rocky Mountain region was made assistant manager of foreign operations. In the same move, John Cox was named chief engineer and manager of domestic land drilling operations. He was previously in charge of engineering and maintenance at Kerr-McGee's Morgan City, Louisiana, headquarters. Marvin Bender, regional drilling engineer, took over Cox's engineering duties in the Gulf Coast. C. D. Blanchard, formerly a toolpusher, was named assistant Gulf Coast drilling superintendent for Kermac.

R. C. "Bob" Tucker, president of Great Western Drilling Co., also of Midland, Tex., was recently elected a vice president of the Texas Mid-Continent Oil & Gas Association to represent the Permian Basin area on the association's executive board.

W. J. Price

Loffland Brothers Company, Tulsa, Oklahoma, also announced promotions of key drilling men in its expanding operations in the Eastern Hemisphere. W. Jess Price, former manager of European operations, was elected vice president and general manager — Eastern Hemisphere. He will continue to headquarter in The Hague, Holland. J. Wayne Burris was appointed assistant general manager — Eastern Hemisphere. He will reside in Benghazi, Libya, where he formerly was superintendent of operations. John M. Reynolds was promoted to chief engineer — Eastern Hemisphere from chief engineer in Argentina and Libya. He will continue to operate out of Loffland's Libyan headquarters in Benghazi.

J. W. Burris

J. M. Reynolds

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Offshore's Newest Platform Design

The Offshore Company, international drilling contractors specializing in offshore drilling, Baton Rouge, La., will put into service in January its third new drilling platform. The new design is a three-legged floating drilling platform built by J. Ray McDermott & Co., and incorporating a new idea in jacks for the legs. The platform of Offshore's Rig 58 is 97½ ft long, 80 ft wide and a hull depth of 12 ft. The drilling slot measures 22½ ft by 30 ft. A 136-ft standard derrick is cantilevered over the side by means of a key-way slot.

Each of Rig 58's three 140-ft long caisson-legs is equipped with a special 500-ton floating hydraulic pin jack. Extensions, carried on deck to location, are added quickly to the legs to permit the unit to drill in water 100 ft deep. Two 100-ton hydraulic jacks are used to skid the rig into position on the barge deck.

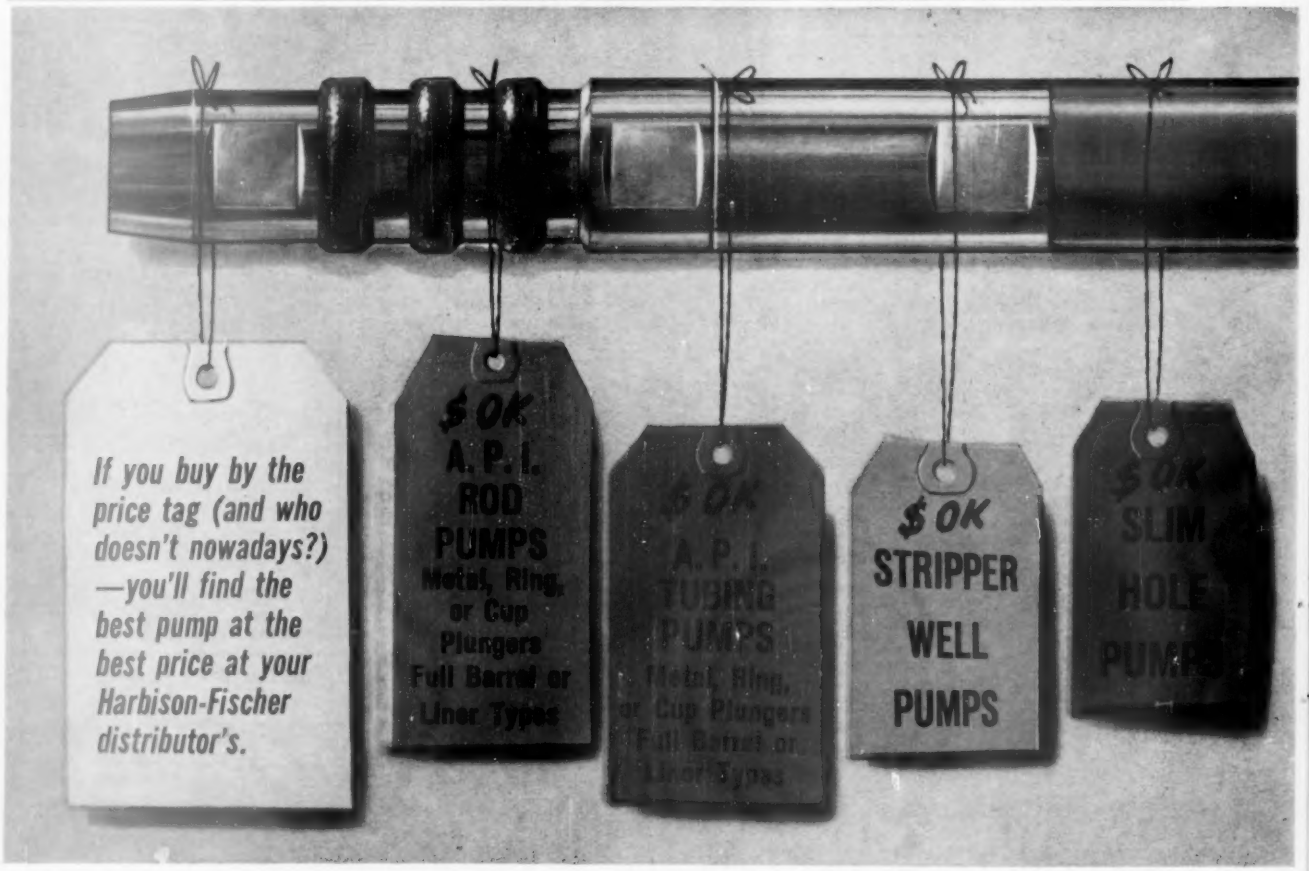
The rig is served by a drilling tender which is equipped with crane, helicopter deck, diesel engines and generators, pumps, equipment storage and handling areas, galley and other facilities. Drill pipe and supplies are transported to location as deck cargo aboard the tender.

New three-legged mobile drilling platform design includes Offshore's floating hydraulic pin-type jacking equipment on each leg. A drilling tender is used with the mobile platform.

Two of the units are already in operation; one is in the Caribbean off British Honduras, another is in the South Atlantic off the coast of Gabon Republic, Africa. The third rig will go in service in January 1962 in Lake Maracaibo, Venezuela.

Gulf Sets Another Record

Gulf Oil Corp. and Brewster-Bartle Drilling Co. have set a new drilling speed record for the Laguna Madre area in the lower Texas Coast. The previous record of 20 days to 8900 ft was cut in half by Brewster-Bartle, Rig No. 17 when it drilled to 8823 ft in 9 days and 19 hours. The record included time for setting casing, waiting on cement, and time required for pulling and re-running drill pipe to change bits. After setting surface casing, nine 8¾-in. bits were used to 8823 ft where drilling was halted to log the well. Average drilling time in the field to about 8000 ft is 18.4 days. Gulf's State Tract 729 No. 1 in Cameron County, Texas, reached this depth in exactly eight days.



AAODC Honors Four at 21st Annual Meeting

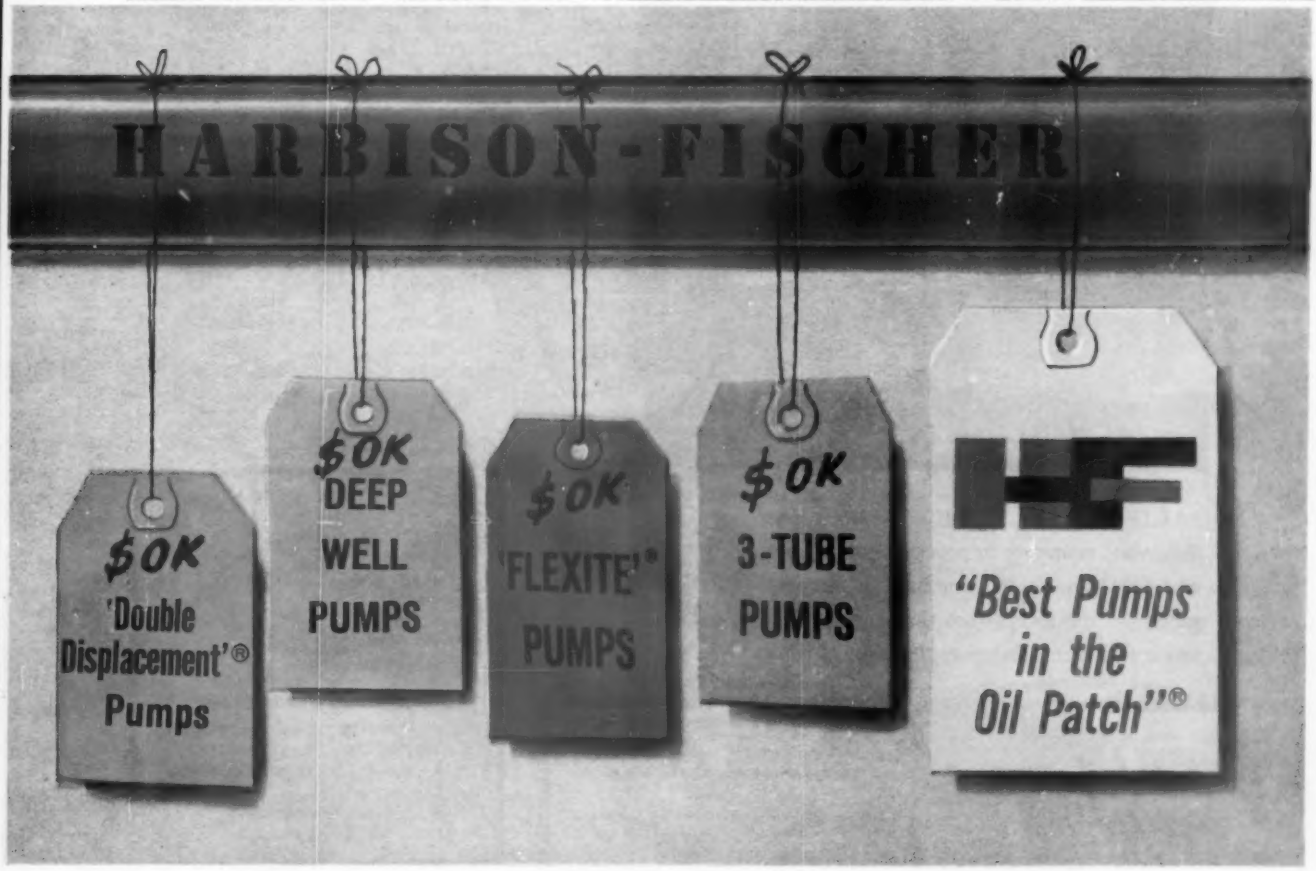
Meritorious service awards were made at the 21st annual meeting by outgoing AAODC pres. John J. Moran, center. Recipients are, left to right; H. B. "Hank" Harkins, pres. Harkins & Co., Alice, Tex., Harry S. Brigham, exec. vice pres. Dixilyn Corp., New Orleans, La., Moran, Earl C. Hellums, pres. D. Gracey-Hellums, Corp., Houston, and C. A. Kinney, drilling engineer, Atlantic Refining Co., Lafayette, La.

Instant Super Pressure Source

Fantastic pressures — up to 500,000 psi — have been generated by a unique process of high voltage capacitor discharge. This unusual technique has reached the commercial stage through the research of Electro-Hydraulics, Inc., Ft. Worth, Tex. Dr. Richard H. Wesley, developer, explains the phenomenon as a high-velocity shock wave resulting from ionization of a metal filament by extremely high electrical energy. This energy is stored in capacitors, then released instantaneously across the filament. The resulting explosion occurs in about 35 microseconds. Immersed in water or other liquids, the high-amplitude shock wave can be controlled and better distributed for many uses.

The experimental machine developed is capable of storing up to 15,000 watt-seconds of energy and can release up to 1,000,000 amperes through the filament almost instantly.

Although current development is in the metal-forming field, this technique holds promise as a source of high energy for use in geophysics, logging, fracturing and other oil field applications.



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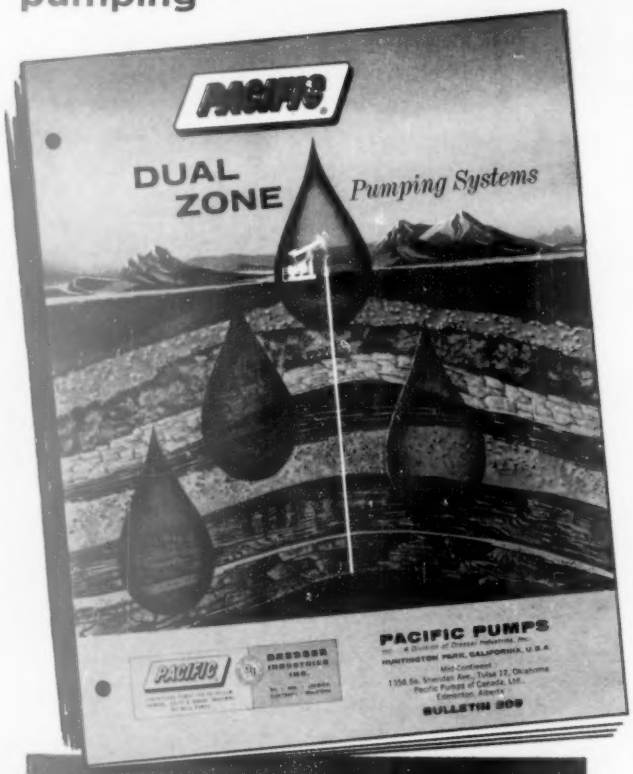

Write for Bulletin 209

PACIFIC DUAL ZONE pumping systems provide maximum economy in producing dual completed wells where co-mingling of zone fluids is not permitted. Both zones are produced from the same well bore, using a single rod string and pumping unit.

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Used Drill Pipe Grades

Just how good or how bad is your used drill pipe may be a relative thing since there exists no standard system of classification. And, once a new string of pipe is run in the hole, it becomes used.

Contractors have relied upon inspection services to provide the answers, but find that the grading by one service does not necessarily coincide with the grading of another service. This difference sometimes makes it confusing when examining the inspection reports, for their proper interpretation requires a knowledge of each grading system.

One inspection service may reserve grade 1 for new drill pipe only, followed by grades 2, 3 and 4 for used pipe. Another service may not apply a number to new drill pipe . . . or to junk pipe . . . but, use numbers 1 through 4 for used pipe only. In some cases, a number 4 rating puts a hex on used pipe for any use other than junk, while in other cases, number 4 used pipe can be used in limited service elsewhere.

Recognizing this dilemma, the AAODC's Drill Pipe Study Sub-Committee, headed by Marvin Parker of Great Western Drilling Co., Midland, appointed a rump committee on drill pipe inspection, chairmanned by Walter B. Reinhold of Abegg & Reinhold, Los Angeles, Calif. Purpose of the inspection group is to come up with a recommended standard system for grading used drill pipe, which recommendation will go to the drill pipe study group for further consideration.

Appointment Made

Howard C. Due has been named vice president and manager of operations of Zapata Off-Shore Co. He was previously a special executive assistant.

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Key to the outstanding performance is the patented Bowen Seal Ring Assembly which consists of Non-Extrusion Rings, Seal Protector Rings and "O"-Rings. The Seal Ring Assembly enables the Bowen Hydraulic Rotary Jar to withstand extreme differential pressures without failure.

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3rd Position: At the upper limit of piston motion, the full energy potential stored in the drill string is available to jar the fish. The intensity of the blow is perfectly controllable, and the jar is easily reset by just setting the weight of the drill string on the jars.

2nd Position: Part way up, the piston enters the fluted section of the cylinder. Resistance to motion drops, and the jar's inner assembly is greatly accelerated by energy stored in the stretched drill string.

1st Position: This drawing shows the jar in the closed position. The piston in the cylinder is in the lowermost position. Piston rings seal between cylinder and piston to retard movement until desired tension is taken on the drill string.

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Bureau of Mines Develops Radioactive Waterflood Tracer

A promising new method for tracing the flow of water, oil and gas underground has been invented by a Bureau of Mines researcher, the Department of the Interior has announced.

The process, which can be used by any United States citizen or organization without royalty payment, upon authorization by the Department of the Interior, was developed by Frederick E. Armstrong, an engineer at the Bureau's Petroleum Research Center, Bartlesville, Okla.

First use of the new method is foreseen in predicting the effectiveness of water-floods in obtaining additional recovery in oil and gas fields.

In applying the new process to waterflooding, a harmless tracer substance dissolved in water is pumped underground through an injection well. Then, after the water has carried the tracer through the formation to a producing well, a sample is taken. The tracer then is made radioactive and its radioactivity is measured with a detector.

This measurement tells how much of the tracer has reached the producing well, thus furnishing valuable information on how waterflooding should be conducted and what results might be obtained in the formation tested.

Most important feature of the Armstrong invention is that radioactivity is not created until after the tracer material has passed through the formation being studied and reaches the check point. Another advantage is that the method uses tracer substances that are not easily filtered out or adsorbed by formations through which they must pass.

Water-soluble salts of several elements that can be made highly but briefly radioactive with short bombardment by neutrons are suitable for the new process.

Applications for using U. S. Patent No. 3,002,091, "Method of Tracing the Flow of Liquids by Use of Post Radioactivation of Tracer Substances," can be made by writing the Office of the Solicitor, Department of the Interior, Washington 25, D. C. ■

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SPANGALOY Rotary Drill Pipe is produced in sizes up to 8⅝" O.D.

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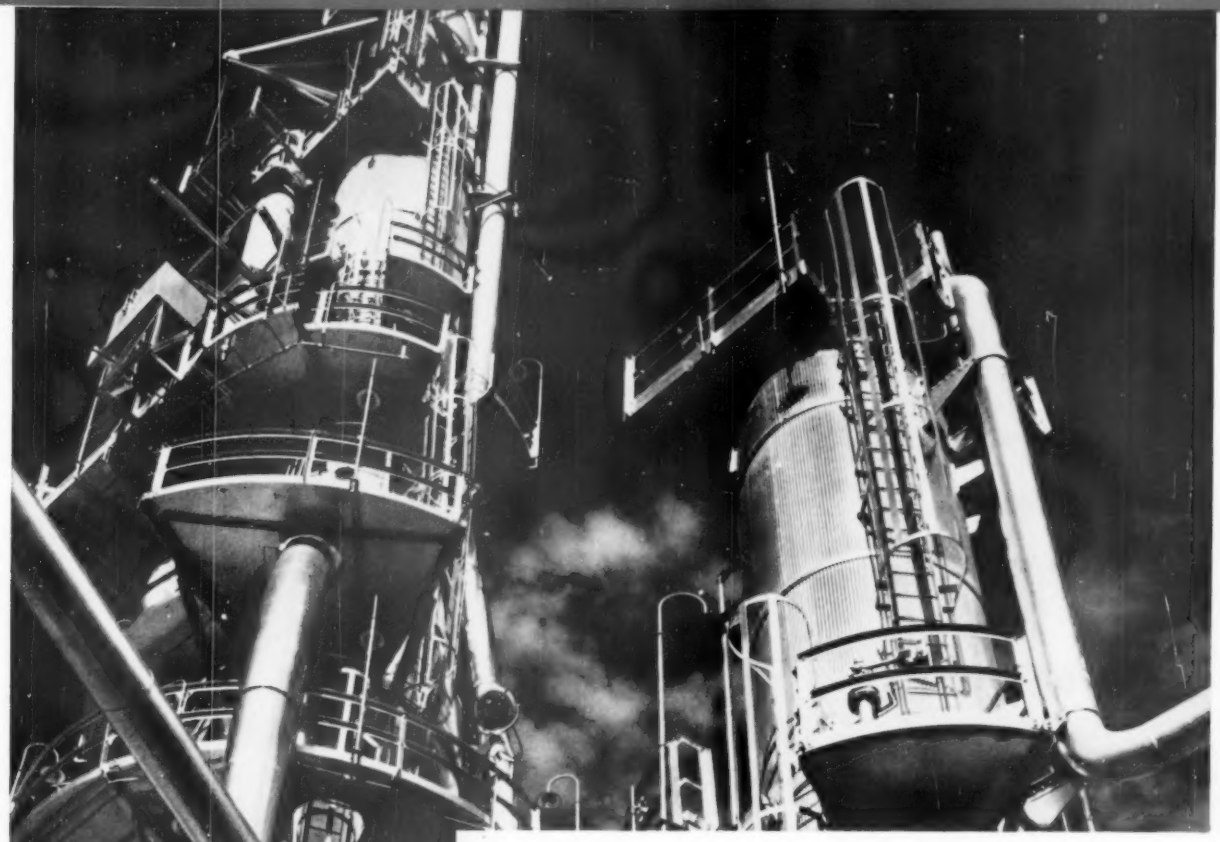

Refractory insulating concrete linings keep cats cracking

Refractory insulating concrete, bonded with LUMNITE calcium-aluminate cement, is being used more and more to line regenerators, cyclones, strippers, catalysts and reactor transfer lines of fluid catalytic cracking units. On stream in FCCs across the country, these industrial concrete linings will resist severe erosion and abrasion caused by catalyst fines ... resist attack by acid condensate ... and provide insulation at high temperatures.

Installation of monolithic concrete linings is fast, easy, economical – whether cast in place, gunited or plastered. Concrete reaches service strength in 24 hours.

For added convenience, castables bonded with LUMNITE cement are available from leading manufacturers of refractories. These are packaged mixtures, ready for use with just the addition of water. For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

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21 Procon-built plants meet benzene demand

The growth of the plastics and synthetic fiber industries has created an increasing world demand for benzene. To help meet this requirement Procon has built or is completing 21 plants . . . in every section of the United States . . . as well as other free world locations such as Germany, Brazil, Canada, The Canary Islands and Australia.

■ Typical of Procon's petrochemical construction, these benzene plants provide adaptability and versatility through the incorporation of the Udex and/or Hydeal processes. Udex permits the recovery of high-purity benzene and other aromatics from petroleum hydrocarbon mixtures . . . while Hydeal allows production of benzene from toluene and xylenes for greater economic flexibility.

■ If you require construction in the chemical, petrochemical or petroleum refining industries . . . no matter what the process, the product or the location . . . Procon can do the job . . . complete it on or before the agreed date . . . to your satisfaction.

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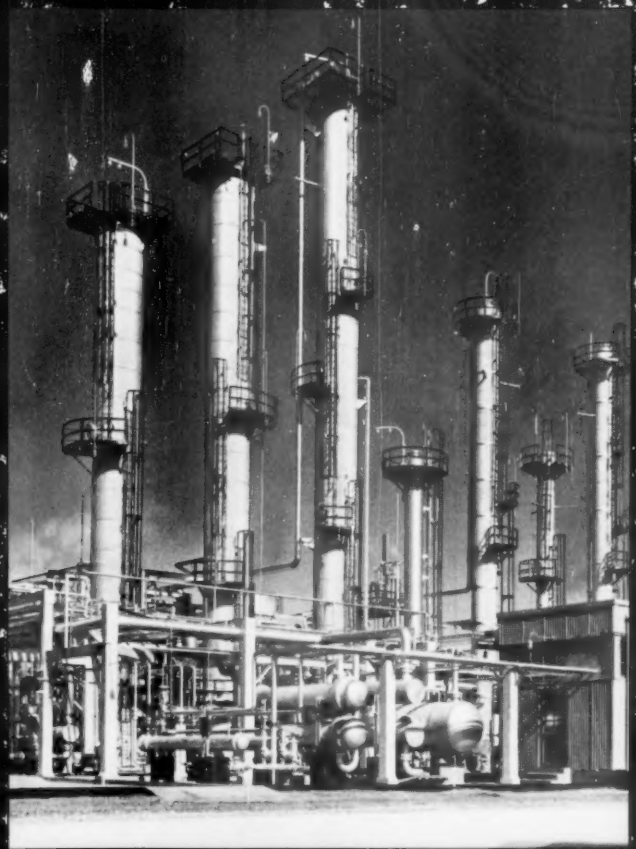

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Construction Briefs

Marbon Chemical, Div. of Borg-Warner Corp., plans a 75,000,000 lb/yr styrene production plant adjacent to Humble Oil & Refining Co.'s Baytown, Tex., refinery. Enjay Chemical Co., a Humble division, will supply ethylbenzene to the Marbon plant by direct pipeline. Construction will start before the end of this year, with completion scheduled for early 1963. This marks the second expansion move by Marbon in less than a month. Also announced are plans to produce acrylonitrile-butadiene-styrene and other synthetic resins at Grangemouth, near Edinburg, Scotland. Unit is expected to cost less than $5,000,000.

Goodrich-Gulf Chemicals Inc. will increase capacity to produce cold styrene-butadiene rubber by some 8% at its plant in Institute, W. Va. Polymerization reactors and related equipment will be added. The contractor, Muehlman Engineering Service Inc. of Charleston, W. Va., has started work and completion is anticipated before year's end.

ANIC, subsidiary of Italian ENI, will construct an oil refinery with annual capacity close to 30,000,000 bbl at Ferrera, Pavia. Completion is expected by mid-1963.

Standard Oil Co. of California has purchased a site on Kenai Peninsula, Alaska, for an $11,000,000 refinery. The project must be underway within five years or the land reverts to the state.

Montecatini, Italian chemical firm, will assist four Indian companies in setting up new plants to produce polypropylene plastics, methanol and formaldehyde and polystyrene resins. Assistance will be equity participation as well as technical aid.

Other new plants announced:

Oil refinery at Bayou Casotte, near Pascagoula, Miss. Estimated cost of this project of Standard Oil Co. of Kentucky and Standard Oil Co. of California is $125,000,000.

Ohio Oil Co. and Wintershall AG's oil refinery in South Germany, possibly near Mannheim. Initial capacity around 15,000,000 bbl a year is expected. Plant may be linked with the Karlsruhe-Marseilles pipeline now under construction.

Eastman Kodak Co.'s expansion of facilities at Longview, Tex., to increase company's capacity for polypropylene 50% to bring it up to 30,000,000 lb. Current unit runs 20,000,000 lb.

Tower Oil & Gas Co.'s $650,000 plant near Shawnee, Converse County, East Wyoming, to process gas from a recent gas-condensate discovery south of the North Shawnee field. Due for mid-December completion, the plant will have initial gas handling capacity of 7,500,000 ft for a yield of 20,000 gal of liquids daily. Later expansion to 20,000,000 ft per day is planned.

FMC Corp.'s multimillion-dollar plant to produce toluene diisocyanate, a major component of polyurethane plastics, on site of former naval ordnance plant at Charleston, W. Va. Construction is scheduled to start early next spring with initial operation in late 1963.

Dominican Republic's first refinery, a $12,000,000 plant with capacity between 10,000 and 15,000 bpd. Government has awarded 12-yr refining rights to Thomas A. Pappas, of Boston, and associates who will own the refinery outright.

Tidewater Oil Co. and associates' $1,000,000 gas processing plant in the Normanna field near Skidmore, Tex.

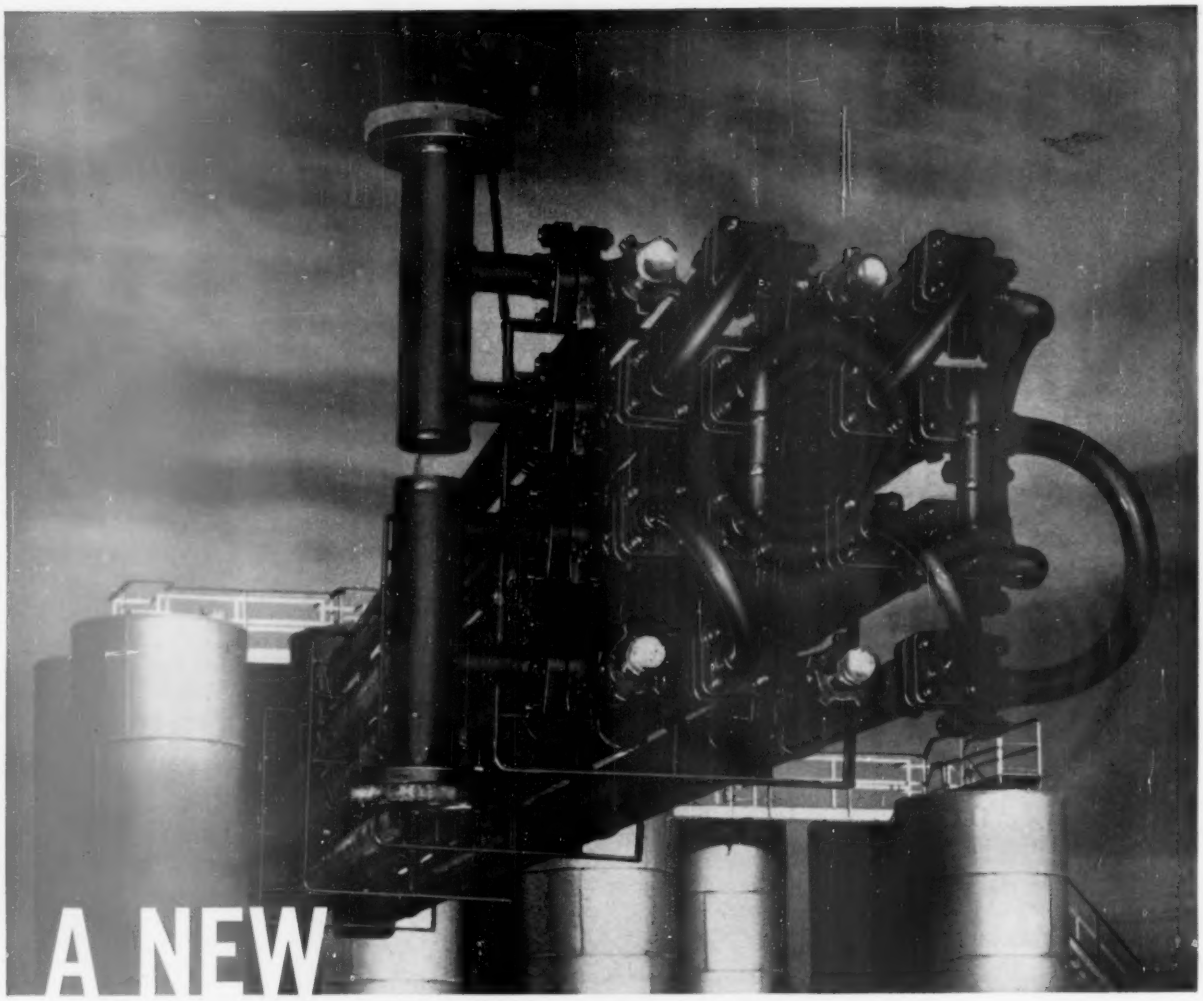
Other key contracts awarded to:

Foster Wheeler Corp. for design and construction of a carbon monoxide waste heat boiler with a capacity of 400,000 lb of steam per hour for Humble Oil & Refining Co.'s Bayway refinery, Linden, N. J. Boiler will be fed by combustion gases from a fluid catalytic cracking unit regenerator. Gases will contain 9% CO and have temperatures of 1050 F.

Procon Incorporated, Des Plaines, Ill., subsidiary of Universal Oil Products Co., for constructing multimillion-dollar petrochemical facilities for Ohio Oil Co. through the subsidiary, Aurora Gasoline Co. This project to construct major new units of Ohio Oil's Detroit refinery, is part of a program to transform Dow Chemical Co.'s Bay City, Mich., plant into the Midwest's major petrochemical plant. When all facilities are completed by the middle of next year, Ohio Oil will supply about 20,000,000 gal of benzene and toluene a year to Dow.

Fluor Corp. Ltd. to construct a Udex unit for Standard Oil Co. of California at its Richmond, Calif., refinery. Completion is scheduled for February.

Badger Manufacturing Co., for design and construction of a 100,000,000 lb/yr propylene purification unit at Cities Service Refining Corp.'s Lake Charles, La., refinery. Cities Service will sell propylene to Hercules as feedstock for its Lake Charles polypropylene plant.



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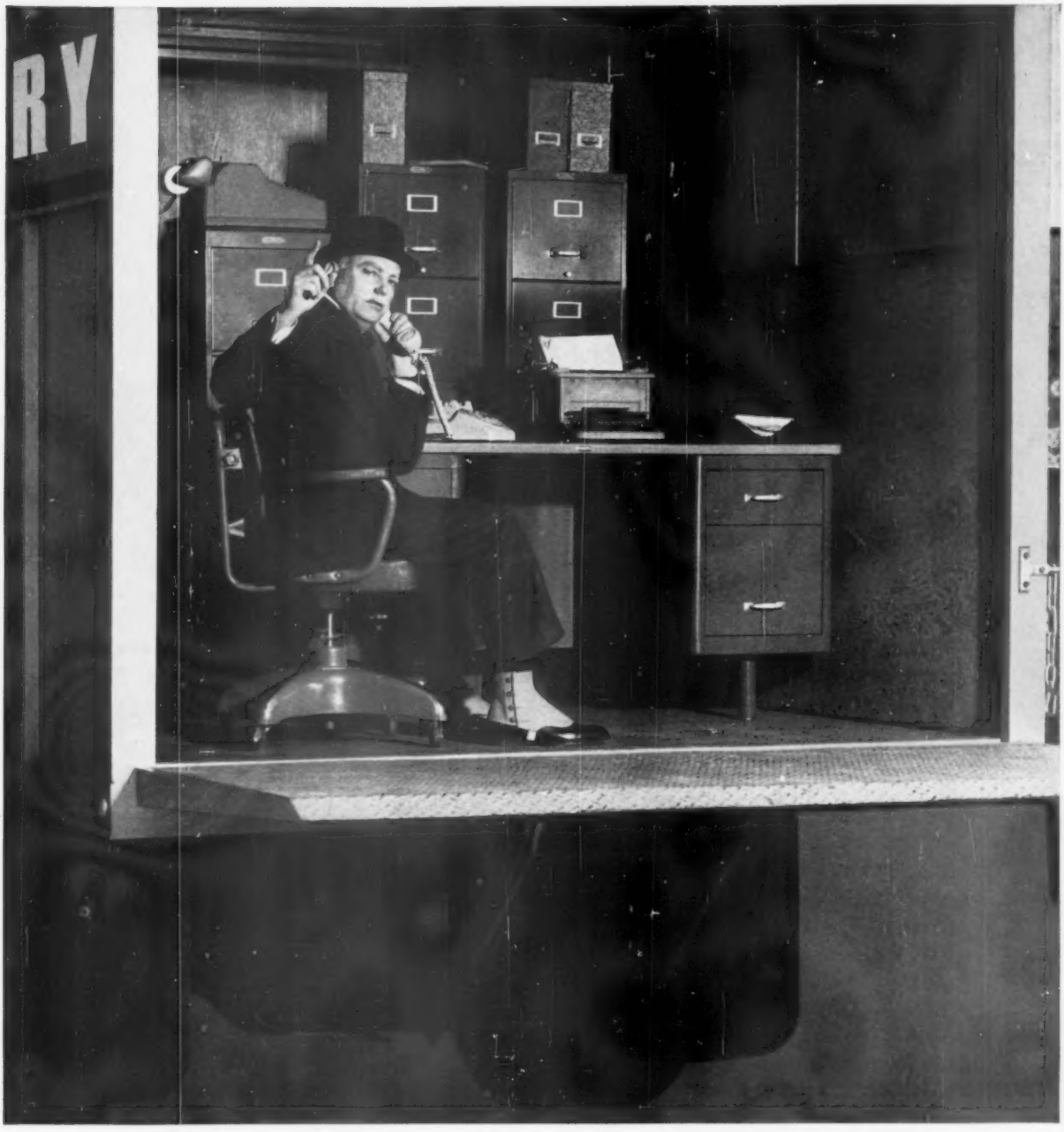

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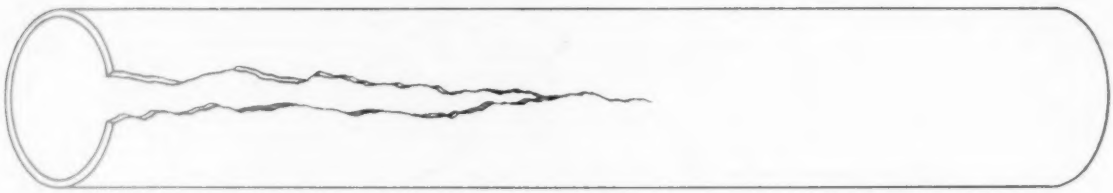

Why do some steel tubes fail under high operating temperatures and pressures?

Basically, it's because the grade of steel and physical and mechanical properties of the tube haven't been matched accurately to specific stress and temperature requirements. As a result, the tube lacks the mechanical strength to resist rupture and creep in continued service.

There is no formula that will produce automatically the right tube for your application. To arrive at a *Job-Matched* tube requires the knowledge of how particular grades of stainless, alloy and carbon steel tubing react under a variety of specific operating temperatures and pressures. And, it takes engineering know-how to determine the proper factors of oxidation and corrosion resistance, tube size, flow rates, and rates of thermal expansion and conductivity that match application requirements.

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Pottery • Printing Ink
Pyrotechnic • Refractories
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Chromium Chloride	Manganese Hydrate	Copper Chloride
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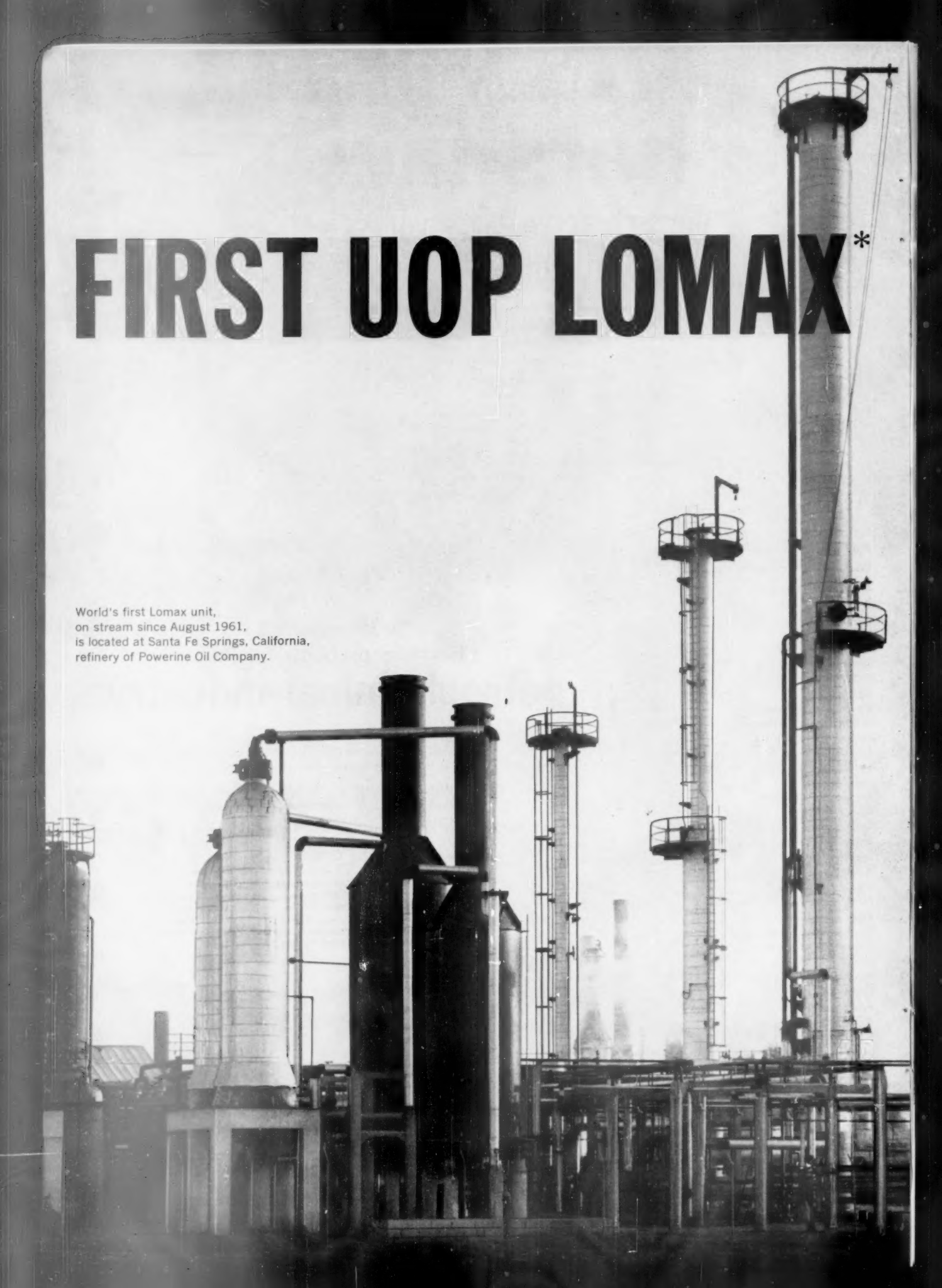

World's first Lomax unit,
on stream since August 1961,
is located at Santa Fe Springs, California,
refinery of Powerine Oil Company.

INSTALLATIONS . . .

Illustrate flexibility, adaptability to market changes.

Already two installations of UOP's new Lomax process are under way. Both provide significant illustrations of the ways in which the process enables refiners to produce the end product their customers want to buy.

ON STREAM AT POWERINE . . . Now on stream at Powerine Oil Company's refinery in Santa Fe Springs, California, is the world's first Lomax unit . . . designed to produce 115 volume per cent of saturated gasoline from refinery distillate . . . 2,537 BSD of C_4-plus gasoline from a combined feed of 440-656°F. boiling range diesel fuel and 200-424°F. thermally cracked naphtha. Nominal charge capacity is 2,200 BSD. However, company officials expect to increase throughput to 3,000 BSD.

APCO UNIT NEXT . . . Under construction is the 2,950 BSD Lomax unit at the Arkansas City, Kansas, refinery of the APCO Oil Corporation. Designed to convert middle distillate oil into high octane gasoline, the new unit will produce 115 barrels of 10-lb. vapor pressure gasoline for each 100 barrels of oil charged. Charge stocks will be combined catalytic, light cycle and virgin gas oil. The unit will produce light gasoline (C_5-C_8) with a 97.5 leaded octane rating. Installed as a major step in a modernization program, the new unit will enable APCO to shutdown existing thermal cracking operations . . . and to maintain its position of supplying high quality products to jobbers and dealers.

MAXIMUM PRODUCT FLEXIBILITY . . . No matter what your geographic location, climatic conditions or other demand variables, the flexibility inherent in the Lomax process should pay significant dividends. Lomax allows the refiner to offer more of the products in demand at any given time . . . gasolines, kerosines, heating oils, jet fuels, whenever your customers are ready to buy. Lomax, essentially a cracking-with-hydrogen process, permits higher liquid yields . . . up to 120 barrels per 100 barrels of charge stock. Lomax middle distillates and gasolines have extremely high purity.

UOP's engineers will appreciate an opportunity to show you how Lomax can provide economic advantages in your specific refining and marketing situation.

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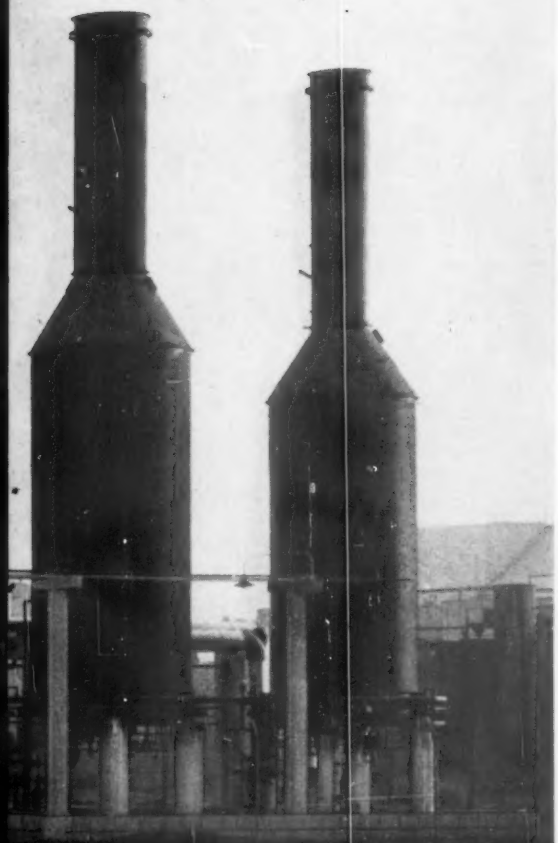

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HELPFUL WATER CONDITIONING DATA FROM BETZ

HOW TO PREVENT BOILER

Troubled with boiler scale? A modern scientific approach will eliminate the problem.

THE FORMATION of scale and sludge deposits on boiler heating surfaces is the most serious problem encountered in steam generating equipment. Blistered boiler tubes and tube failures cause boiler outage and loss in production. In extreme cases, complete shut-down of an entire plant can result.

Through the years, industrial plants have found it more economical to generate steam at higher and higher pressures. At the same time, heat transfer rates have increased to aggravate further the problem of scale and deposit formation. Water treatment technology has kept abreast of these increasing demands by developing more effective external and internal treatment methods.

Softening Process	Residual Hardness, ppm
Cold Lime-Soda	30-50
Hot Lime-Soda	15-25
Hot Lime-Zeolite	0-2
Zeolite	0-2
Sodium-Hydrogen Zeolite	0-2
Demineralizers	0-0.5

Figure 1

Figure 1 lists the more common external treatment methods that are employed and the range of residual hardness that usually results. The selection of the method of external treatment is governed by the operating pressure, water characteristics, economics and other factors. Obviously, the higher the operating pressure the more complete must be the job of external conditioning. However, no system of external treatment is in itself adequate protection against boiler scale without the use of supplementary internal chemical treatment of the boiler water. Even the small amounts of hardness present in the effluent of zeolite softeners will produce troublesome deposits.

Mechanism of Scale Formation

Basically, scale formation occurs because the solubility of the scale forming salts decreases as temperature increases. Consequently, the higher the temperature (and pressure) of boiler operation, the more insoluble become the scale forming salts. The chief mechanism of scale formation is the result of crystallization of the scale forming salts from the thin, viscous film of boiler water adjacent to the heating surface where the bubbles of steam originate. The generation of steam bubbles produced by vaporization of the water film causes the dissolved substances in the film to concentrate. Consequently, the solubility of the scale forming salts is first exceeded in this thin film rather than in the main body of the boiler water. The salts with the least solubility will crystallize out first and scale will form on the tube surfaces even when the solubility of the scale forming salts is not exceeded in the boiler water proper.

The calcium and magnesium salts are primarily responsible for scale deposits. With untreated boiler water calcium silicate, calcium sulfate and calcium carbonate will crystallize on the tube surfaces as a hard adherent scale. Magnesium salts deposit primarily as magnesium silicate and magnesium hydroxide.

Prevention of Scale

Prevention of the crystallization of scale-forming salts from the thin film adjacent to the heat transfer surface is accomplished by precipitating the calcium and magnesium salts in the main body of the boiler water in their least soluble form. As a result, the concentration of calcium and magnesium in the film will be negligible. To accomplish these results, calcium is precipitated as the phosphate and magnesium as the hydroxide and/or silicate. These precipitates can settle and bake on the heat transfer surfaces in the

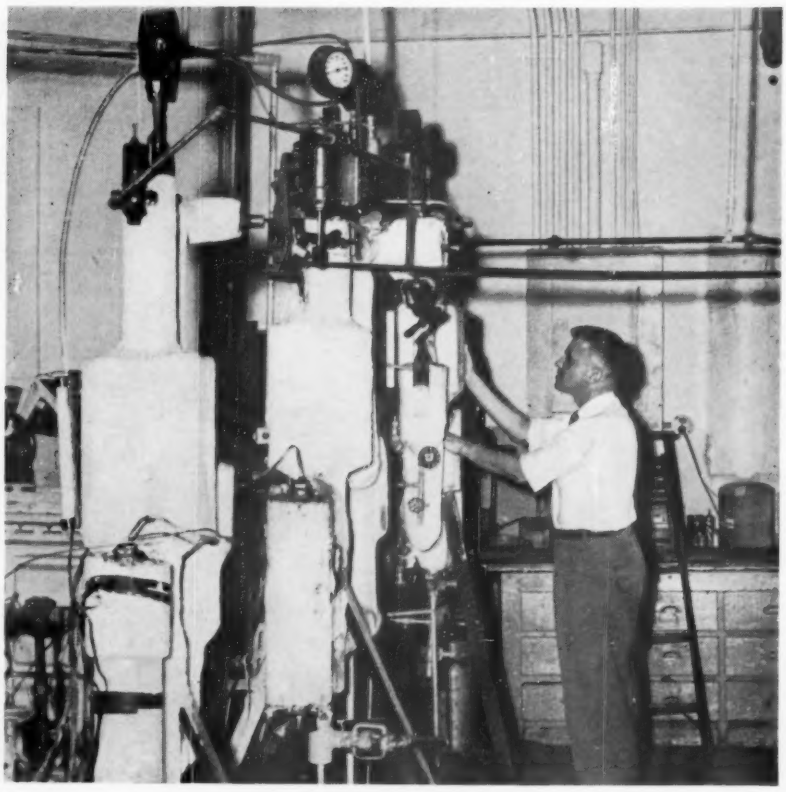
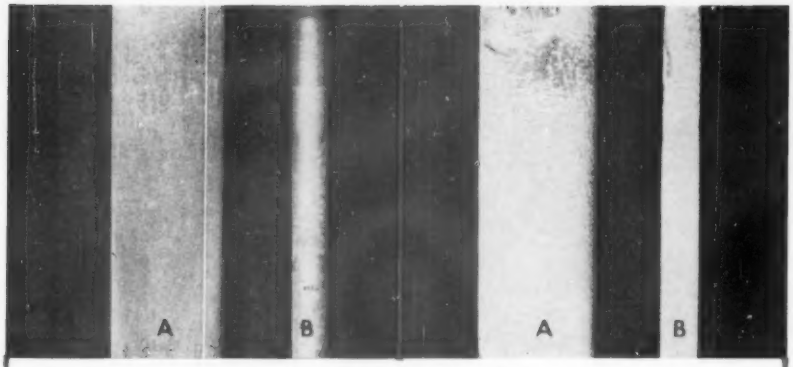


Figure 2—Experimental boilers.



Deposit, grams per sq ft.

With Sludge Conditioner		Without Sludge Conditioner	
A	B	A	B
0.03	0.12	1.20	5.80

Heat transfer A=28,000 Btu/sq ft/hr; B=180,000 Btu/sq ft/hr

Figure 3

DEPOSITS

form of objectionable deposits, unless they are maintained in a dispersed form as a fluid, non-adherent sludge. Accordingly, further conditioning of these precipitates by organic dispersing agents serves to convert them to a sludge that can be removed by boiler blowdown.

Organic Sludge Conditioners

Starches, tannins, lignins, colloids and other organic agents possess to a varying degree the ability to maintain calcium and magnesium precipitates dispersed in the form of sludge. The ability of various organic agents to accomplish sludge conditioning has been the subject of extensive research. At Betz Laboratories, specially designed experimental boilers such as those shown in Figure 2, are used to develop the most stable and effective sludge conditioning agents available.

These experimental boilers are equipped with feed systems, water level control, blowdown and the safety devices necessary for continuous, automatic operation. The heat input is accomplished by electrical heating elements which serve as the scaling surfaces and have heat transfer rates ranging between 28,000 to 180,000 Btu per square ft. per hour. Figure 3 shows the low and high heat transfer scaling surfaces from a duplicate experiment with and without the use of an organic sludge conditioning agent. The effectiveness of the organic sludge conditioning agent is readily evident.

Other Deposits

Another source of concern is silica. Complex silica deposits, which may or may not include calcium and magnesium in their structure can occur in boilers operating at high pressures and at high heat transfer rates. The silica tolerances for various boiler operating pressures have been well established for prevention of boiler scale and for prevention of silica vaporization with the steam.

Blowdown can be used to control silica concentrations to the proper tolerance levels. When excessive blowdown is required, external silica removal processes should be employed to restrict boiler water silica concentrations within established limits.

The concern for silica is not always because it is too high. In some cases silica can be too low. This situation occurs primarily with waters that contain high magnesium concentrations and low silica values. In these special cases magnesium will tend to precipitate as magnesium phosphate which produces a sticky sludge. Precipitation in this form is aggravated when the feedwater enters in a region of low alkalinity and poor circulation. Under these conditions, increasing the silica content of the feedwater to avoid magnesium phosphate precipitation will prove helpful. However, this practice must be applied within the normal silica tolerances established for the boiler operating pressure. Other factors that must be considered are increased boiler water alkalinity, the use of special organic sludge condition agents and better mixing of the feedwater.

Iron Oxide Deposits

Deposits consisting predominantly of iron oxide are frequently found in boilers operating with very pure feedwater. In such plants, the makeup water requirements are usually low. The usual sludge forming calcium and magnesium salts may amount to less than 5% of the boiler deposit. The origin of such deposits can usually be traced to corrosion external to the boiler. Corrosion of iron or steel in the condensate or preboiler system will permit substantial amounts of dissolved iron to enter the boiler where precipitation will occur as a result of the higher temperature and alkalinity conditions of the boiler water. Prevention of iron oxide deposits originating from corrosion external to the boiler can most effectively be controlled by eliminating the condensate corrosion problem. The materials most commonly employed for this purpose are the neutralizing or filming amines. Where carbon dioxide concentrations are low and dissolved oxygen negligible the neutralizing amines will prove effective and economical. Where carbon-dioxide concentrations are high the use of the filming amines will prove more effective and economical.

Iron oxide deposits originating from attack of the boiler metal can also result. One special case of such attack occurs from steam blanketing. The water and steam oxidize the hot steel to black magnetic oxide at hot spots in the boiler. These problems are associated with extreme heat input and faulty or low circulation and usually lead to tube failures.

Betz research has produced the products and know-how to handle all phases of your boiler water conditioning problems effectively and economically. If you would like additional information regarding Betz service at your plant, we will be happy to have you write us. Why not do it *today?*

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■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

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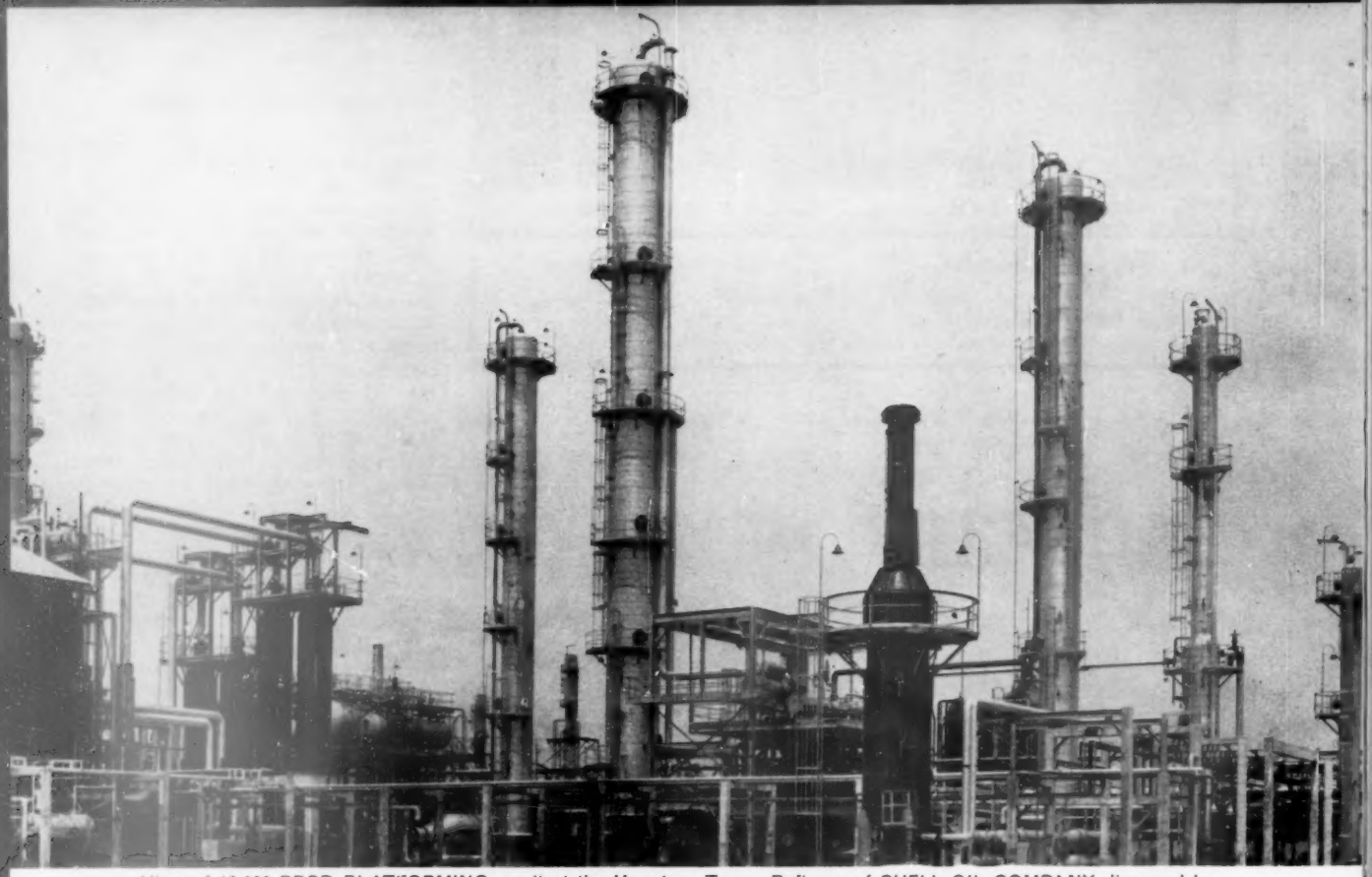

View of 16,000 BPSD PLATFORMING® unit at the Houston, Texas, Refinery of SHELL OIL COMPANY, licensed by UNIVERSAL OIL PRODUCTS COMPANY and designed in conjunction with Shell.

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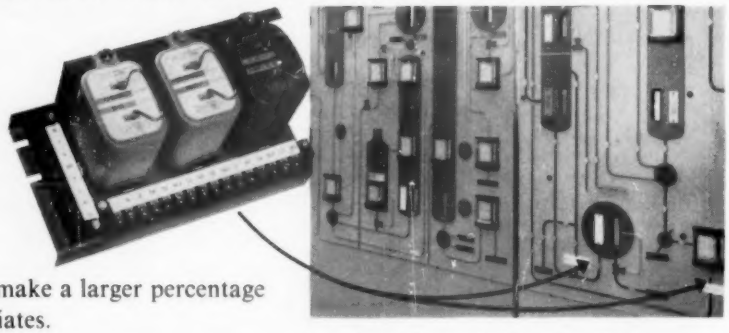
The Panalarm remote system is particularly suited for central graphic control panels used in most refining processes. Back-lighted nameplates are conveniently located in the process flow and actuated remotely by hermetically sealed alarm relays mounted in strip chassis or adapter cabinets. Meets Class I, Group D, Division 2 requirements.



Panalarm Annunciators warn Platformer T.M. operators when undesirable conditions develop at critical points by illuminating appropriate translucent plates on this graphic control panel, only a portion of which is shown. When desired, a simultaneous audible signal also attracts attention.

The Platforming® process enables a refiner to make a larger percentage of top quality gasoline and petrochemical intermediates.

Every major oil and petro/chem firm uses reliable Panalarm Annunciators.

Panalarm maintains a large staff of annunciator engineering specialists to assist with special annunciator design and application problems. For your specific annunciator requirements, contact Panalarm; sales and engineering offices are in all principal cities. Your inquiry will receive prompt attention.

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Finding a path through today's antiknock maze

Which antiknock would *you* choose for a standard, compact or economy car? For a low or high compression engine? For a stick-shift or automatic transmission? For 4, 6 or 8 cylinders — straight or V? To help refiners choose the best antiknock for *each* blending requirement at the lowest cost, Du Pont is in the midst of a continuing study of the variables involved. For an up-to-now report on that study,

turn the page...

■ *A recent Du Pont study showed one refiner how he could save $19 per 1,000 barrels of regular gasoline and $64 on his premium grade by changing antiknocks.*

■ *Another refiner could save $15 on regular and $20 on premium.*

■ *The same Du Pont study that made these and other such success stories possible may help YOU sort out the variables that control antiknock selection today, yielding the octane rating you want at the lowest price possible.*

How Du Pont research helps refiners choose the right antiknock for each situation

Wilmington, Del.: The Du Pont Petroleum Laboratory is currently in the midst of a continuing program comparing the antiknock performance of TEL, TML and TETRAMIX® lead alkyl mixtures in a variety of fuels.

This study has already paid off for a number of refiners, by showing which of the many available antiknocks can do the best job of octane improvement *per dollar spent*.

As refiners are well aware, performance of the "new" antiknocks varies greatly from fuel to fuel and from engine to engine. Road octane values can differ greatly from Research and Motor octane results. A full testing program must be conducted on every fuel before the refiner can safely say, "*This* antiknock is best for my fuels".

Du Pont's continuing research provides such assistance.

PROBLEM: How Volatile?

The gasoline you sell to the driver of a stick-shift, 4-cylinder compact may need a different antiknock than that used in an automatic-shift V-8. The Du Pont study has thrown dramatic light on the significance of the differences in volatility of TML, "TETRAMIX" and TEL – and the need for greater volatility in the fuel distribution systems of certain groups of cars. TML and "TETRAMIX" are more volatile than TEL, and have clear-cut advantages in attaining desired Road Octane values in such automobiles.

PROBLEM: What Concentration?

Further results of this study show that, of the new

antiknocks, TML is generally most useful in manual transmission cars with fuels having low front end octane quality. "TETRAMIX" provides advantages over TEL in a variety of fuels, with its advantage increasing at higher octane and lead levels and higher aromatic contents.

PROBLEM: How Many Dollars?

Out of all this research comes the practical advantage of learning exactly which antiknock will work best in your fuel on the basis of overall cost. As a rule, the study indicates that TEL is still the most economical antiknock with respect to both Research and Road octane number in most fuels, with "TETRAMIX" proving best for a significant number of fuels and TML winning out in isolated cases.

More Details Available

Our Petroleum Laboratory is prepared to share this study with oil refiners and marketers, and to work individually with you on choosing the most economical antiknock for your fuel. For further details, contact your Du Pont representative. E. I. du Pont de Nemours & Co. (Inc.) Petroleum Chemicals Division, Wilmington 98, Delaware. • Trademark

Antiknocks and other Petroleum Additives

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REG U.S. PAT. OFF.

Better Things for Better Living
... through Chemistry

DISCOVERY ABOUT COMPOSITION

New scientific

SOCONY MOBIL scientists have made a basic discovery about the *composition* of petroleum which also helps solve the mystery of its *origin*.

For the first time, two specific portions of the chlorophyll molecule have been conclusively identified in petroleum. These substances—pristane and phytane—had eluded petroleum researchers for a century. Most scientists doubted that they existed in oil even as mere traces. Socony Mobil scientists have succeeded not only in *identifying* these chlorophyll derivatives, but also in *isolating* them in pure form.

It all began in 1957, when Joe Bendoraitis and Belva Brown were checking some mass spectrum studies of petroleum in a Socony Mobil laboratory. They noticed that the sawtoothed line on the graph had some peaks that stood out like Mount Everests in the otherwise orderly pattern.

It seemed almost futile to the two scientists to try to determine precisely what substance caused the peaks, since petroleum contains perhaps *hundreds of thousands* of different components. Nevertheless they set out to try.

In late 1959 Len Hepner joined them. He was one of the first scientists to use a new instrument, the gas chromatograph, to study the higher boiling ranges of petroleum. With it he could perform in hours work that would have taken months with former methods. He isolated from a sample of petroleum a single drop of the substance that was causing the high peaks.

The three scientists were now beginning to

Research technologist Belva Brown analyzing "mass spec" charts. A University of Texas mathematics graduate, Mrs. Brown worked with the Signal Corps before joining Socony Mobil in 1946. Her leisure activities: oil painting and photography.

Len Hepner, senior research chemist, graduated from the University of Pittsburgh in 1946. His work with the gas chromatograph isolated pristane and phytane from petroleum—and led him to neglect his hobbies of bridge, bowling and tennis.

OF PETROLEUM

knowledge also sheds light on its origin

approach an answer.

Mrs. Brown, with 10 years of "mass spec" experience, kept searching her files of charts for a clue as to what substance showed peaks like that. Finally, she found one with a similar pattern.

This substance was a derivative from shark-liver oil—which contains some pristane. But the biggest source of pristane is chlorophyll, the abundant green constitutent of plants and algae.

What about the peaks Mr. Bendoraitis and Mrs. Brown had detected in the mass spec chart *from petroleum?* Did *they* indicate the presence of pristane?

The three Mobil scientists were positive they did. Their discovery so startled them that they almost doubted it themselves. But they set about proving their findings, step by step. Identifying and isolating pristane had taken four years, since the research had to be sandwiched into their regular assignments. *Proving* they had found it was to take another year.

They now called on new and powerful analytical tools, some of which Socony Mobil was the first oil company to use. They applied nuclear magnetic resonance spectrometry, infrared spectrometry, and hi-mass spectrometry—in unique fashion in many instances. In the process, they discovered a *second* chlorophyll derivative—phytane—and identified and isolated it.

All the tests confirmed their findings. Pristane and phytane are present in perceptible quantities *in petroleum. They can be isolated. And the existence of these two chlorophyll derivatives in petroleum supports the theory that oil was formed through the conversion of material derived from plant and animal life.*

This discovery is so important to fundamental petroleum research that a paper describing it has been recommended by the U.S. Committee for inclusion at the Sixth World Petroleum Congress to be held in Germany in 1963.

Joe Bendoraitis, Belva Brown, and Len Hepner are among the 1,500 men and women engaged in Socony Mobil's $25,000,000-a-year research program—in which imagination is turned into ideas, and ideas into better products and processes.

Probing the far frontiers of science pays off not only for Mobil, but for everyone who does business with Mobil—customers, employees, licensees, and investors.

Senior research chemist Joe Bendoraitis uses nuclear magnetic resonance spectrometer in verifying discovery of chlorophyll derivatives in petroleum. A ham radio operator, photographer, bowler, and stamp collector, he is earning his Ph.D. at night.

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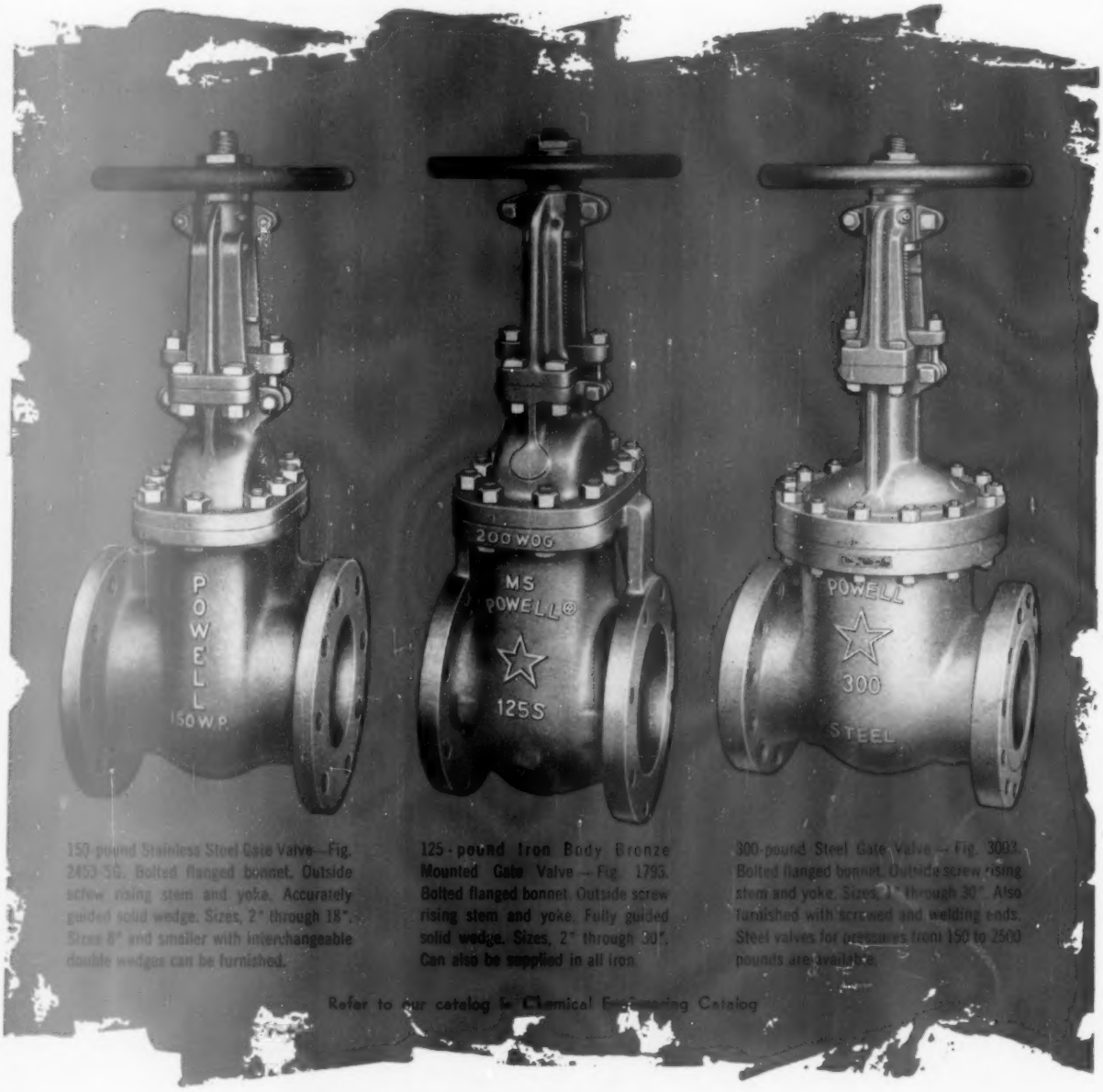

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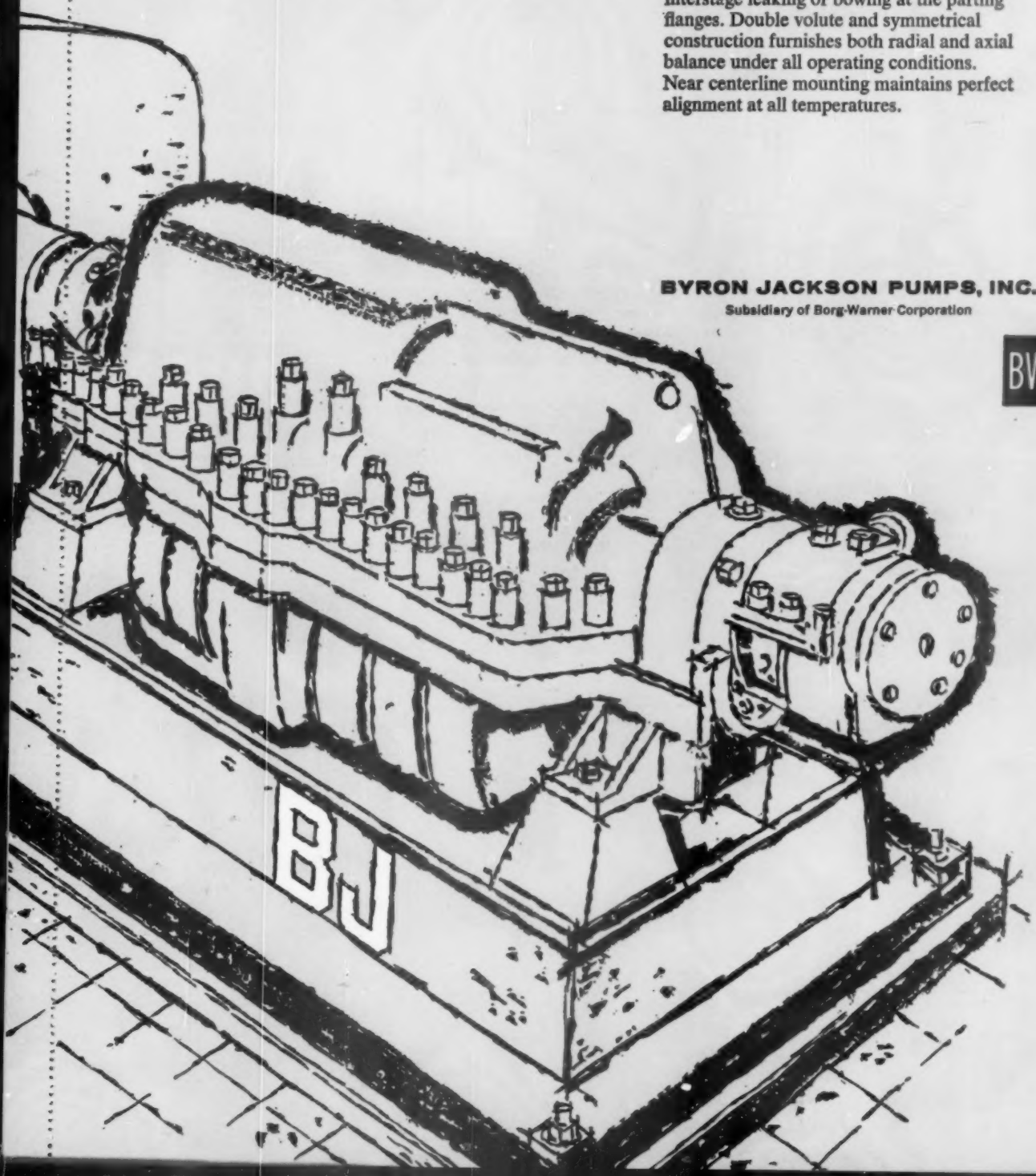

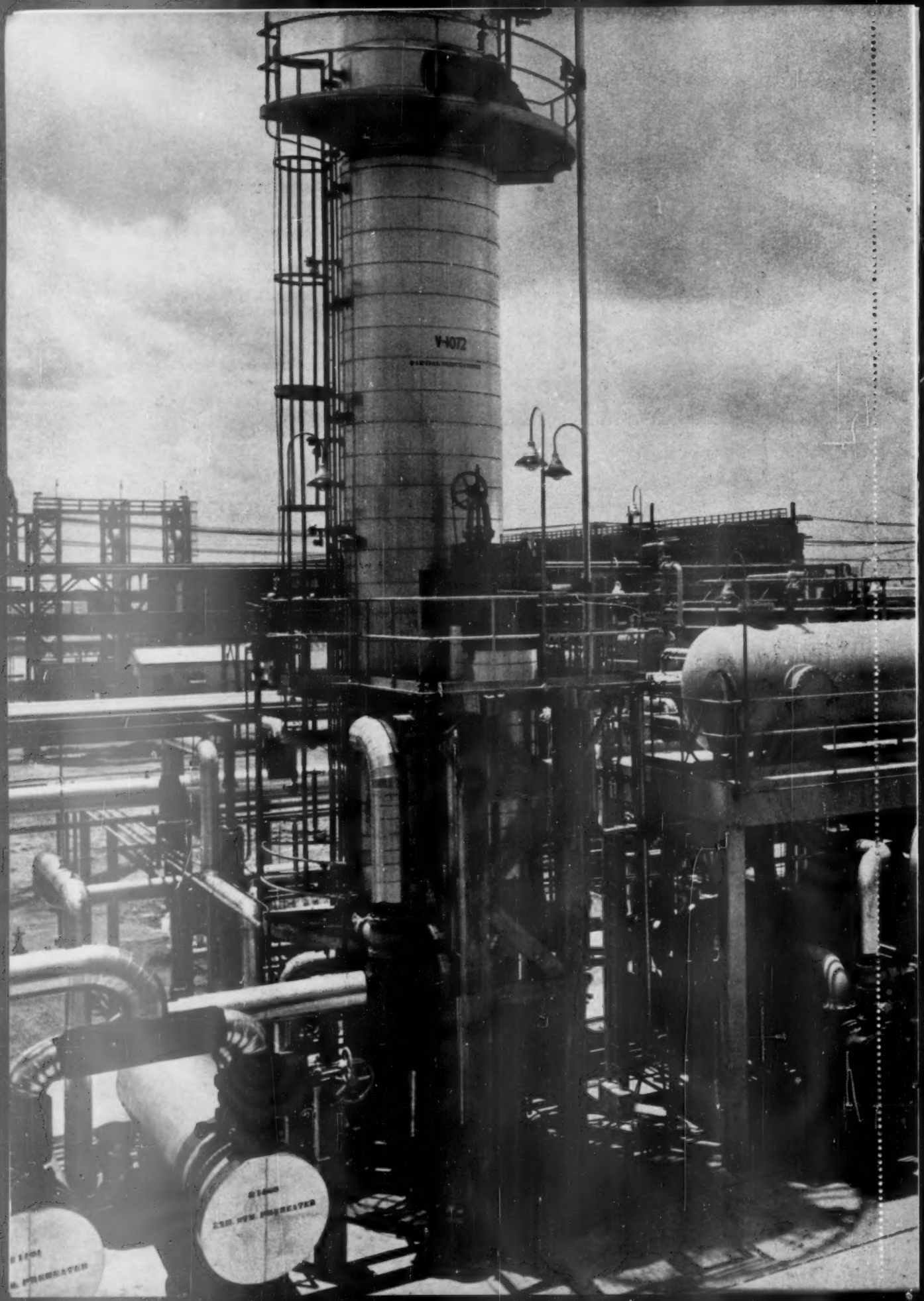
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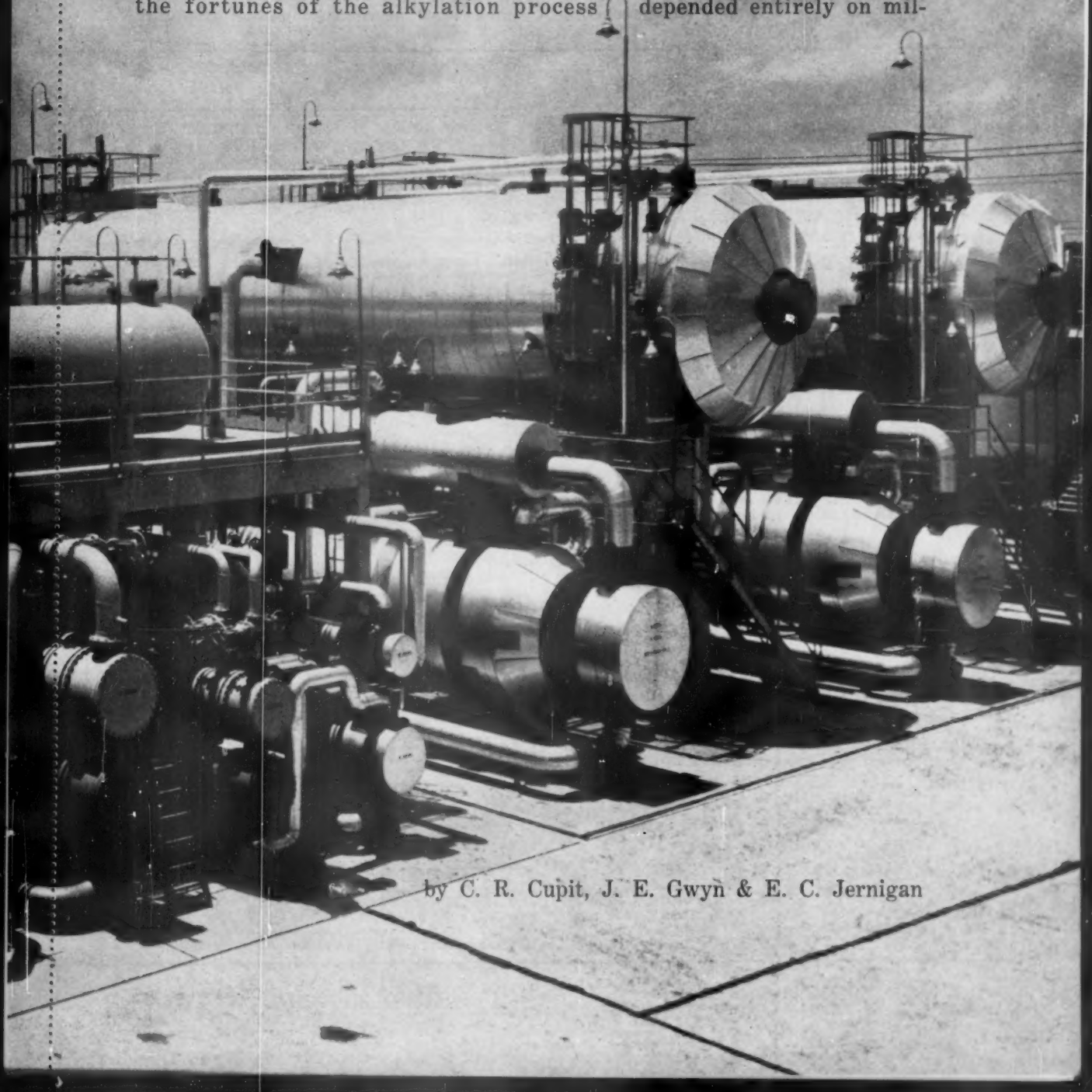
SPECIAL REPORT
CATALYTIC ALKYLATION

With increasing use of alkylates for upgrading motor fuels, the alkylation process — combining light olefins and isoparaffins to produce high quality gasoline range isoparaffins—now plays a special role in the refining scheme. Here is a thorough analysis of the process, covering the reaction mechanism, catalyst characteristics, effect of important variables, types of reactor systems and factors involved in plant operations.

The demand picture has changed greatly since World War II, when the fortunes of the alkylation process depended entirely on mil-



by C. R. Cupit, J. E. Gwyn & E. C. Jernigan

itary demands for aviation gasoline. At the end of the war, by which time total capacity had reached 150,000 bpd,[69,71] about half the plants then existing were shut down.[69] Expansion of commercial aviation and requirements for the Korean War brought alkylation capacity to 236,000 bpd by the beginning of 1955,[103] but demand for aviation gasoline stabilized at 186,000 bpd in 1956.[64] It is expected to taper off slightly by 1964.

The competitive race for higher octane numbers, need for lower gasoline sensitivity and the increasing cost for the incremental octane numbers are major factors behind the trend to use alkylate as a motor fuel component. This began in 1956 when alkylation capacity for upgrading motor fuels reached 55,000 bpd. As much as 35% alkylate has been used in some premium-grade motor gasolines.[64]

Alkylation capacity has almost doubled since 1955 (Table 1). Sulfuric acid alkylation capacity is about three times that of hydrofluoric acid alkylation.

The excellent antiknock properties of the highly branched isoparaffins provide alkylate with special roles for both aviation and motor fuel. Relative antiknock characteristics by the various scales are summarized for a number of alkylates in Tables 2 through 5 and in Fig. 1. Comparison of research (F-1) and motor (F-2) octane numbers of alkylates indicate low sensitivities (Table 2). In some instances, negative sensitivities have been measured. The road octane numbers are especially high as indicated by comparisons with a reformate of the same leaded research number (Table 3). In addition to these high road ratings, alkylate produces no rumble[64] and has excellent lead susceptibility (Fig. 1). The high aviation ratings of a butene alkylate are shown in Table 4. These ratings

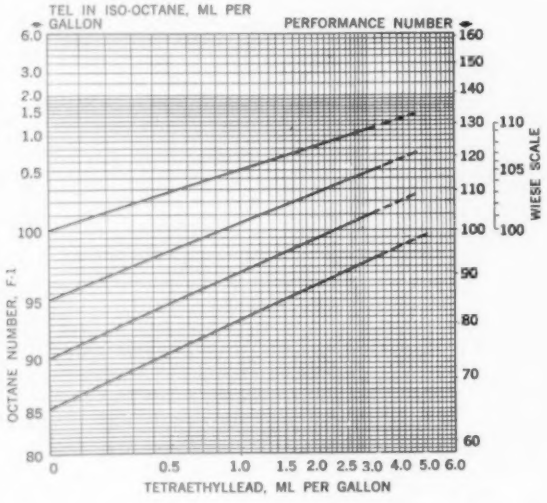


FIG. 1. Approximate lead susceptibility of alkylate (Research octane number).[57]

Table 1. United States Alkylation Capacities.[8,9,103,104,105]

Date	Sulfuric acid Bbl/stream day	Sulfuric acid % of crude	Hydrofluoric acid Bbl/stream day	Hydrofluoric acid % of crude	Total Bbl/stream day	Total % of crude
1/1/55	186,614		49,614		236,228	
1/1/56	197,869		65,540		263,409	
1/1/57	212,659		59,960		272,619	
1/1/58	244,615	2.5	65,750	0.7	310,365	3.2
1/1/59	290,400	2.85	79,720	0.79	370,126	3.64
1/1/60	311,280	3.01	96,145	0.93	407,425	3.94
1/1/61	323,405	3.08	101,686	0.97	425,091	4.05
1/1/62 (est.)	335,705		108,886		444,591	

Table 2. Unleaded Octane Numbers of Alkylates.[57]

F-1 (Research)	F-2 (Motor)	Sensitivity
88.6	87	1.6
91.6-95	89.8-93	1.8
96-98	94-95	2.5

Table 3. Comparison of Leaded Octane Numbers of Alkylate and Reformate.[99]

Method	3 cc TEL/gal ratings Reformate	Alkylate
F-1 (Research)	103	103
F-2 (Motor)	94	104
Modified borderline		
2000 rpm	103	108
3600 rpm	103	106
Modified Uniontown	103	107

Table 4. Aviation and Supercharged Ratings of a Butene Alkylate.[79]

Octane ratings	
F-3+4.6 cc TEL/gal	I.O.*+1.9 cc TEL/gal
F-4+4.6 cc TEL/gal	I.O. +3.6 cc TEL/gal
Octane numbers	
F-3+4.6 cc TEL/gal	110
Performance numbers	
F-3+4.6 cc TEL/gal	137
F-4+4.6 cc TEL/gal	150

* I.O. =isooctane

Table 5. Blending of Butene Alkylate for Aviation Gasoline.[79]

Blend composition, vol %				
Butene alkylate	100	90	80	70
Heavy Platformate	0	10	20	30
Performance numbers				
F-3+4.6 cc TEL/gal	137	132	127	121
F-4+4.6 cc TEL/gal	150	155	172	193
Blending performance nos. of Platformate*				
F-3+4.6 cc TEL/gal	—	87	87	84
F-4+4.6 cc TEL/gal	—	197	257	294

* Assuming alkylate blends at its actual performance number.

are typical of commercial alkylates; however, F-4 + 4.6 cc TEL per gal performance numbers as high as 165 have been reported for commercial butene alkylates.[70]

The blending characteristics of alkylate are important to its use as a fuel component. Blending with about 15% Platformate has been desirable for balance in aviation ratings. As shown in Table 5, Platformate has a high F-4 appreciation while alkylate has a high F-3 rating and can tolerate a considerable quantity of Platformate in 115/145 grade aviation gasoline. This characteristic permits alkylation with some lower quality propene and pentene feed components. Specific data for blending of alkylate into motor fuels are limited due to the relatively recent nature of its importance for this purpose.

As a class, isoparaffins blend linearly with other isoparaffins while showing positive deviations with naphthenes and olefins. Aromatics show mixed responses to isoparaffins. Calculations of gasoline blending octane ratings are generally based on the olefin contents of the blending stocks. Nomographs for determining motor and research octanes were reported by Mapstone.[52] For a more complete account the reader is referred to publications based on API Research Project 45.[90, 91, 106]

Table 6. GLC-Mass Spectrometric Component Analyses of Finished Alkylates.[92]

Component	H_2SO_4 alkylate vol %[a]	HF alkylate vol %[a]
Propane	0.05	—
Isobutane	0.04	0.13
n-butane	0.92	4.87
Isopentane	8.76	5.10
n-pentane	0.23	0.01
2, 2-dimethylbutane (DMB)	—	—
2, 3-dimethylbutane	5.36	2.38
2-methylpentane (MP)	1.29	0.91
3-methylpentane	0.64	0.40
n-hexane	—	—
2, 2-dimethylpentane (DMP)	0.25	0.17
2, 4-dimethylpentane	3.62	1.95
2, 2, 3-trimethylbutane (TMB)	0.01	—
3, 3-dimethylpentane	0.01	—
2, 3-dimethylpentane	2.15	1.31
2-methylhexane (MH)	0.22	0.24
3-methylhexane	0.14	0.12
3-ethylpentane (EP)	0.01	0.01
2, 2, 4-trimethylpentane (TMP)	24.20	38.02
n-heptane	—	—
2, 2, 3, 3-tetramethylbutane (TMB)	b	b
2, 2-dimethylhexane (DMH)	0.04	—
2, 4-dimethylhexane	2.89	4.19
2, 5-dimethylhexane	4.94	3.57
2, 2, 3-trimethylpentane	1.53	1.35
3, 3-dimethylpentane	b	b
2, 3, 4-trimethylpentane	13.15	9.63
2, 3-dimethylhexane	3.41	4.90
4-methylheptane (MH)	—	—
2-methylheptane	0.08	0.09
2, 3, 3-trimethylpentane	11.47	8.14
3, 4-dimethylhexane	0.26	0.59
3-methylheptane	0.23	0.19
2, 2, 5-trimethylhexane (TMH)	7.20	3.20
	93.10	91.50

a Basis total finished alkylate.
b Qualitatively indicated to be absent.

Analyses of Alkylates

Since alkylates are complex mixtures of highly branched isoparaffins, the state of knowledge of the process has been paced by the development of analytical methods. Detailed compositional analyses of 20 different alkylates reported in 1946[22] represented 510 to 1100 hr of precision distillation per sample. Analyses of alkylates by infrared spectrometric methods described during the following year[101] reduced the time required to 14 to 16 hr.

The development of gas-liquid chromatography (GLC) within the last few years has provided a convenient means for rapid and accurate analyses of alkylates. The GLC analysis in Fig. 2 indicates a separation according to boiling point.[92] Mass spectrometric analyses of cuts from the GLC separation showed each peak generally to represent one or two predominant isoparaffins. Complete compositional data through 2, 2, 5-trimethylhexane by combined GLC-mass spectrometric analyses are shown in Table 6. Capillary GLC columns now permit finer resolution without the need for mass spectrometic analysis of the cuts.

Component analyses provide not only the information for investigating reaction mechanisms but also a convenient means of estimating properties of the alkylates. Infrared absorption (9.18μ) has been correlated with F-1 clear octane ratings,[34] with the correlations based on the relationship between infrared absorption and the degree of branching of the isoparaffins. Extensive correlations of antiknock ratings with component compositions were reported by Webb and Galloway.[101]

Antiknock ratings of the major alkylate components are listed in Table 7. The trimethylpentanes as a class have the highest antiknock ratings on all scales. However, isooctane (2, 2, 4-trimethylpentane), normally the largest single component of the octane fraction, has lower ratings than the other trimethylpentanes on the F-1 (research) and F-4 scales. On the F-2 scale, which is of increased importance due to greater use of alkylates in motor gasolines, isooctane has a higher rating than the other trimethylpentanes. A comparison of the antiknock ratings of 2, 3- and 2, 4-dimethylpentanes, the principal heptane isomers in propene alkylate,

reveals that the former is a higher quality component on all scales.

These particular effects of the trimethylpentane and dimethylpentane isomers emphasize the desirability of relating composition to reaction mechanism. The effect of operating conditions on alkylate quality becomes more reasonable with this knowledge.

Reactions, Theory and Thermodynamics

Alkylation as practiced in petroleum refining is essentially a process for combining butenes with isobutane, although alkylation of other components is practiced. Despite the relatively small number of reactive components present in feed, contact with acid-type catalysts such as sulfuric acid, hydrofluoric acid or aluminum chloride results in many sequential and parallel reactions which give rise to a complex product structure. The alkylate product contains both primary and secondary reaction products. While the same components are generally present in alkylates produced from different olefins and isoparaffins, relative yields of these components differ markedly. Relative yields are governed by factors which affect the approach to thermodynamic equilibrium and the relative rates of the simultaneous reactions.

Current knowledge of alkylation reactions and theory is based largely upon the results of many and diverse experiments. These include variations of olefins,[5,25,49,54,85] isoparaffins,[5,49,54] catalysts,[25,54,85] and operating variables; exchange reactions using tertiary-alkyl halides,[17,85,87] deuterated and radioactively tagged isomers[67,94]; alkylation of polymers[19,22,54]; and disproportionation tests.[5,11,53,89,102]

Primary and Secondary Reactions

Primary product is defined here as product favored by operating at conditions which preferentially produce a single isomer while minimizing side reactions. Low temperature and short contact time are required to produce high yields of primary product. Primary products of the most important isoparaffin-olefin combi-

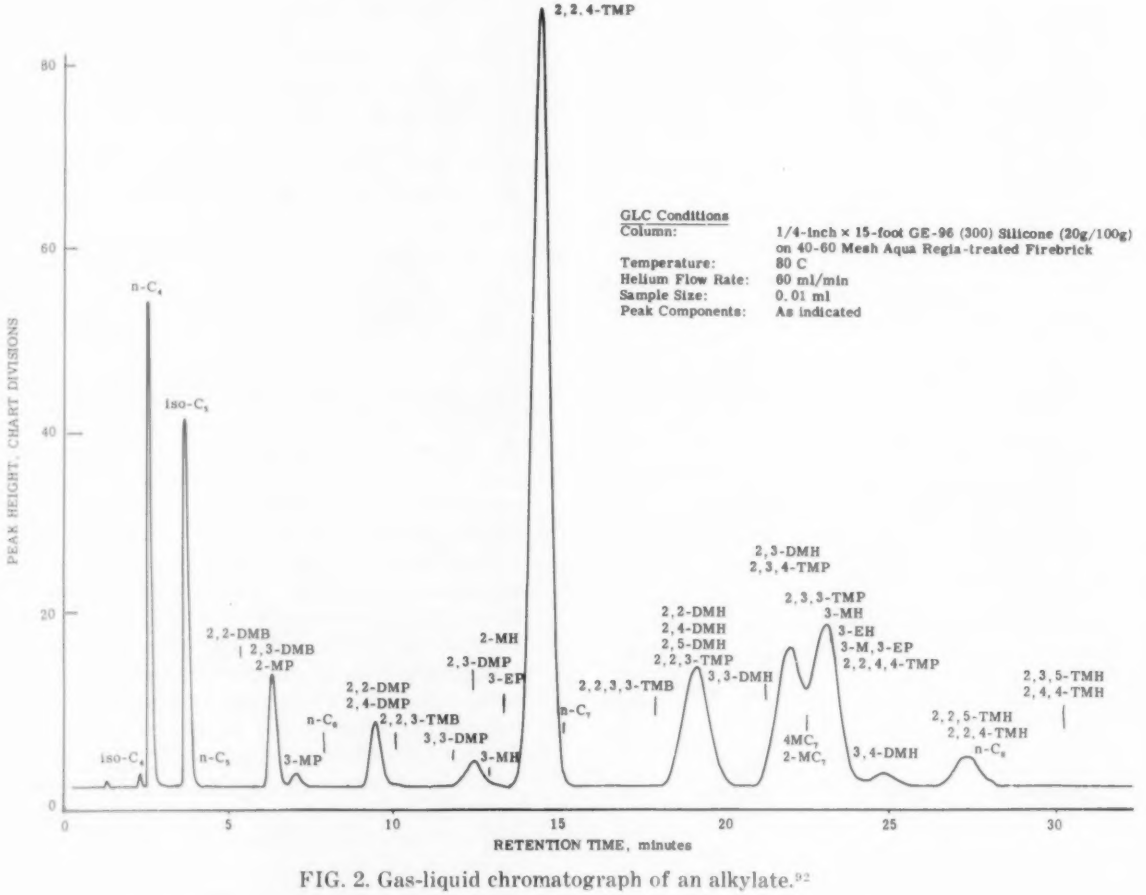


FIG. 2. Gas-liquid chromatograph of an alkylate.[92]

nations have been reported.[25,43,94] Gorin, Kuhn and Miles,[25] for example, alkylated isobutane with various butenes at 14 F and a contact time of 5 min with hydrofluoric acid catalyst and observed that 2, 3-dimethylhexane constituted about 60% of the octane fraction from 1-butene alkylation (Table 8), only 3% of the octane fraction from 2-butene alkylation and was not present at all in isobutene alkylate. The primary products from isobutane alkylation of ethene and propene are 2, 3-dimethylbutane and 2, 3-dimethylpentane, respectively (Table 9). Thus, 2, 3-dimethylalkanes were found to be the primary products from all normal olefins having a double bond in the terminal position. Primary product from 2-butene alkylation is 2, 3, 4-trimethylpentane, and that from isobutene alkylation is 2, 2, 4-trimethylpentane (Table 8).

Important secondary products which are always formed regardless of the olefin used include isopentane, 2, 3-dimethylbutane and 2,2,5-trimethylhexane; also, isobutane is formed when isopentane is used as isoparaffin feed in place of isobutane. Other secondary products always produced when the isoparaffin and olefin feeds are of different carbon number are isomers having a carbon number identical to that of the feed olefin and isomers having a carbon number twice that of the feed isoparaffin.

Theory of Reactions

Only isoparaffins containing a tertiary carbon atom are found to undergo catalytic alkylation with olefins. The various reactions and products are readily explained by the carbonium ion mechanism. The carbonium ion concept as proposed by Whitmore[107,108] has been applied to alkylation by Birch and Dunstan,[5] Schmerling[84,85,86] Bartlett, et al.[4] and others. Carbonium ions, as intermediates in the reaction scheme, have been applied with equal success to related acid-type catalyzed processes such as isomerization,[86] catalytic cracking[7,13,26,29] and olefin polymerization.[86,107,108] Only an outline of the theory as applied to alkylation will be given here to demonstrate the type of reactions

Table 7. Properties of Alkylate Components.[2,19,60]

Component	bp, F	Antiknock ratings F-1 (Research) Clear	F-1 (Research) +3.0 cc	F-2 (Motor) Clear	F-2 (Motor) +3.0 cc	F-4+4cc Perf. No.
Isopentane	82.2	92.3	(+1.0)[a]108.6	90.3	—	142
2, 3-DMB	136.4	(+0.3) 103.5	—	94.3	(+1.8) 112.1	205
2-MP	140.5	73.4	93.1	73.5	91.1	66
3-MP	145.9	74.5	93.4	74.3	91.3	66
2, 2-DMP	174.6	92.8	(+0.4) 104.4	95.6	(+2.4) 114.0	143
2, 4-DMP	176.9	83.1	96.6	83.8	99.1	83
2, 3-DMP	193.6	91.1	(+0.3) 103.5	88.5	(+0.3) 103.5	140
2-MH	194.2	42.4	73.2	46.4	74.5	(90)[c]
3-MH	197.6	52.0	74.7	55.8	81.0	(80)[c]
2, 2, 4-TMP	210.6	100.0	(+3.0) 115.5	100.0	(+3.0) 115.5	154
2, 5-DMH	228.4	55.2	81.6	55.7	82.9	44
2, 4-DMH	228.9	65.2	87.3	69.9	89.0	(80)[c]
2, 2, 3-TMP	229.7	(+1.2) 109.6	—	99.9	(+2.0) 112.8	238
2, 3, 4-TMP	236.6	(+0.2) 102.5	—	95.9	(+0.7) 106.7	193
2, 3, 3-TMP	238.6	(+0.6) 106.0	—	99.4	(+2.0) 112.8	225
2, 3-DMH	240.1	71.3	91.7	78.9	93.7	102
2, 2, 5-TMH	255.4	91[b]	—	88[b]	—	(150)[c]
2, 3, 5-TMH	268.5	81[b]	—	78[b]	—	(120)[c]
Isoparaffins	259-284	—	—	(75.7)[c]	—	(100)[c]
Isoparaffins	284-318	—	—	(35)[c]	—	(100)[c]
Isoparaffins	318-352	—	—	—	—	(60)[c]
Isoparaffins	>352	—	—	—	—	(60)

a For octane numbers above 100, numbers in parenthesis are isooctane plus cc TEL/gal. Numbers are octane rating on Wiese scale.
b Blending octane numbers.
c Estimated.[60]

Table 8. Alkylation of Isobutane with Butenes and HF Catalyst at Conditions Favoring Primary Product and Favoring Thermodynamic Equilibrium.[25,75]

Olefin	Favoring primary product 1-Butene	2-Butene	Isobutene	Favoring thermodynamic equilibrium 1-Butene	2-Butene	Isobutene	Equilibrium composition
Temperature, C (F)	—10 (14)	—10 (14)	—11 (12)	49 (120)	49 (120)	47 (117)	41 (106)
Contact time, min	5	5	5	250	250	259	
Octanes, %							
2, 2, 4-TMP	14.0	38.9	74.8	32.5	37.0	39.7	29.6
2, 4-DMH	5.2	4.5	8.4	43.6	33.9	31.5	56.8
2, 3, 4-TMP	21.3	39.1	16.8	12.0	11.9	17.8	4.5
2, 3, 3-TMP	—	14.2	—	—	8.3	5.0	3.4
2, 3-DMH	59.5	3.3	—	11.9	8.9	6.0	5.7
C_8 in C_8+Alkylate, wt %	63.1	80.4	64.5	39.2	35.7	41.2	

involved. Knowledge of these reactions provides background for an understanding of the observed differences in alkylate structure when feed components and operating variables are altered.

A molecule containing a carbon atom which has a deficit of two electrons in its outer shell is referred to as a carbonium ion and carries a positive charge. The carbonium ion is the cation member of the ionic pair which also involves an anion of the catalyst. Because the anion plays a less prominent role than the carbonium ion, the anion member of the ionic pair is normally dropped for convenience when writing reactions involving carbonium ions. The relative stability of carbonium ions decreases in the order tertiary > secondary > primary. Tertiary carbonium ions are the only ones regarded as stable enough to undergo saturation via reaction with an isoparaffin. Other carbonium ions are so unstable that they rapidly isomerize to a tertiary ion. The types of reactions involving carbonium ions are summarized as follows (where X is OSO_3H or F), with typical examples given to illustrate each reaction type.

1. Proton addition to olefin:

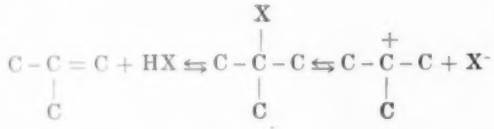


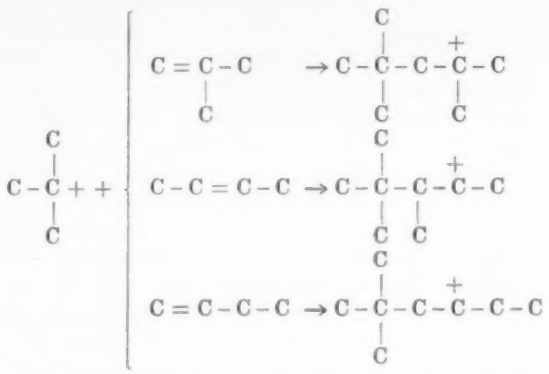
Table 9. Alkylation of Isobutane with Ethene and Propene Using $AlBr_3$ Catalyst at Conditions Favoring Primary Products.[25]

Olefin	Ethene		Propene	
Temperature, C (F)	50 (122)		17 (63)	
Residence time, min	225		4	
Wt % in C_5-C_8 Alkylate	2, 2-DMB	4.0	2, 4-DMP	4.6
	2, 3-DMB	78.9	2, 3-DMP	78.3
	Other	17.1	Other	17.1
		100.0		100.0

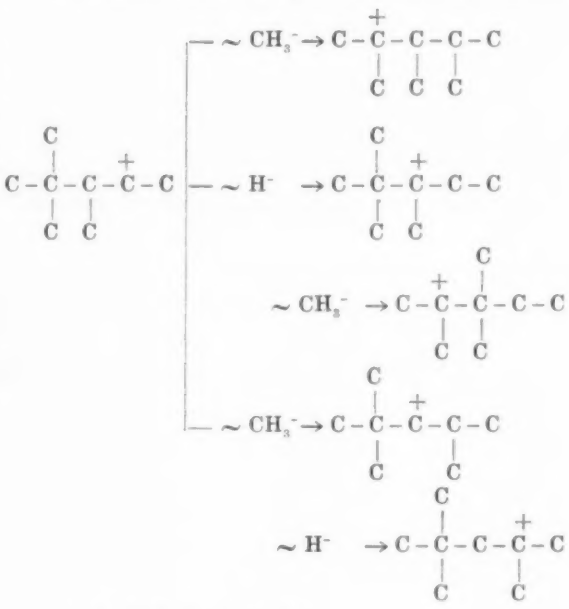
Table 10. Alkylate Disproportionation via Contact with HF Catalyst.[102] (Temperature, 150 F; Ratio Alkylate/HF in Bomb, 5/1.)

Contact time, hr	0	384	576
Composition, vol %			
Isopentane	7.5	7.5	4.4
Hexanes	5.2	8.2	11.0
Heptanes	6.9	9.3	8.7
2, 2, 4-trimethylpentane	34.0	9.7	5.4
Dimethylhexanes	13.9	9.0	8.5
2, 2, 3-trimethylpentane	0.4	0.7	0.8
2, 3, 4-trimethylpentane	11.9	2.5	1.7
2, 3, 3-trimethylpentane	5.8	4.3	2.8
Methylheptanes	0	2.0	2.6
C_9-and-heavier	14.4	46.8	54.1

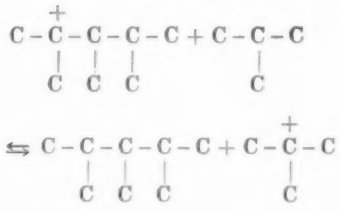
2. Carbonium addition to olefin:



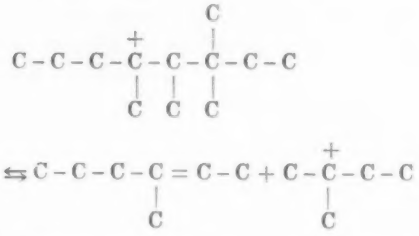
3. Isomerization via hydride and methyl shifts:



4. Hydride-ion transfer:



5. Cracking:



These reaction types are believed to be fundamental to the alkylation process and are used to explain the formation of both primary and

secondary products. All the reactions are to some extent reversible. Although isobutane and butenes were used as typical examples, the reaction types illustrated also apply to other isoparaffins and olefins.

Olefins accept protons from the catalyst via Reaction Type 1 which serves to initiate the carbonium ion chain. If the olefins involved in reactions of Type 1 are other than isobutene, the carbonium ions which result may form t-butyl carbonium ions via isomerization reactions and/or hydride-ion transfer reactions with isobutane. As would be expected by this mechanism, initiation rates are reported to be slower with linear olefins than with branched olefins.[95]

The reaction sequence for formation of primary product then involves addition reaction of a t-butyl carbonium ion and olefin via reactions of Type 2 to form a higher molecular weight carbonium ion; isomerization of this carbonium ion to a more stable form via hydride and methyl shifts shown as reactions of Type 3; and saturation of the final tertiary carbonium ion via hydride-ion transfer from isobutane, reactions of Type 4, to yield an alkylate isoparaffin and a t-butyl carbonium ion which serves to maintain the carbonium-ion chain. Cracking is listed as a separate reaction type rather than as the reverse of Reaction Type 2 because the initial carbonium ion formed by Reaction Type 2 may isomerize prior to cracking, thus yielding a carbonium ion and olefin different from the initial components of the addition reaction. Intramolecular hydride and methyl shifts, shown as Type 3 reactions, are postulated to occur normally by transfer from carbons adjacent to the carbon containing the positive charge.[107] However, a methyl shift from the second to the fourth carbon to form the 2, 3, 4-trimethylpentyl carbonium ion is postulated, as shown, since 2,3,4-trimethylpentane is observed to be the primary product from 2-butene alkylation.

Important Secondary Reactions

Although reactions which lead to secondary product are implicit in the reaction types already given, some secondary reactions are so important that they have been given names.

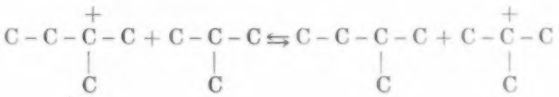
Polymerization is the addition of a second olefinic group to a carbonium ion formed by primary reactions. In the case of isobutane-butene alkylation this can lead to the production of C_{12}-carbonium ions. Because cracking rates of carbonium ions increase rapidly with molecular weight, higher yields of C_7-and-lighter material normally result when polymerization occurs in butene alkylation.

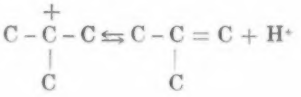
Isomerization of the tertiary carbonium ions initially formed reduces the yield of primary product and favors approach to thermodynamic equilibrium of the permissible isomers.

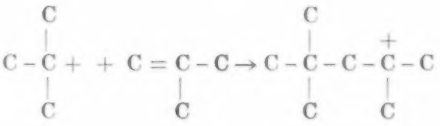
Hydrogen transfer or self-alkylation is important when the isoparaffin and olefin alkylated are of different carbon numbers. Regardless of the olefin employed, hydrogen transfer reactions provide a route for the production of trimethylpentanes when the feed isoparaffin is isobutane.[4,53,54,86,89] The overall reaction is

$$2\ i\text{-}C_4H_{10} + C_nH_{2n} \rightarrow C_8H_{18} + C_nH_{2n} + 2$$

During isobutane alkylation of pentenes, for example, t-amyl carbonium ions are formed which give rise to the reactions







Isopentane and trimethylpentanes are formed in much higher yields from the alkylation of branched pentenes than by alkylation of linear pentenes. Because two moles of isobutane are consumed per mole of olefin, the reaction is commercially undesirable when isobutane supply is limited. Hydrogen transfer alkylation of propene, which yields propane, is an important reaction in hydrofluoric acid alkylation.[36] This does not appear to be the case in sulfuric acid alkylation.

Disproportionation is the destruction of certain alkylate isoparaffins via further reaction before the alkylate has been removed from the reactor. Isoparaffins present in alkylate may under some conditions re-enter the reaction scheme via hydride-ion transfer reactions,[4,11] such as the reverse of Reaction Type 4, and thus undergo degradation by isomerization, polymerization, cracking, etc. Unfortunately little published data have appeared which is related to the degradation of alkylates via back reaction during alkylation. Results of laboratory experiments have been published[5,11,53,54,89] in which specific isoparaffins were contacted with alkylation catalysts. In most cases, however, these experiments were done under conditions in which olefin feed was not employed and thus concurrent alkylation reactions were not in effect. Therefore, these simple tests reflect rates characteristic of systems having a

dearth of carbonium ions available for hydride-ion transfer reactions.

Nevertheless, some indication of relative disproportionation rates of specific isoparaffins can be gained from these results. Birch[5] found that in contact with sulfuric acid, 2,2,4-, 2,2,3- and 2,3,4-trimethylpentanes, 2,2,5-trimethylhexane and 2,3-dimethylbutane break down to form isoparaffins of higher and lower molecular weight. Of these, 2,3,4-trimethylpentane was indicated to be the most easily attacked and 2,3-dimethylbutane the least. Isopentane, 2,2-dimethylbutane and 2,2,3-trimethylbutane did not disproportionate. Marschner and Carmody[53] contacted several isoparaffins with 96 to 100% sulfuric acid and found the relative rates of disproportionation for the isoparaffins used to be in order 2,2,4-trimethylpentane > decane fraction of alkylate > 2,6-dimethylheptane > 2, 3-dimethylbutane > 2, 2, 3-trimethylbutane. Webb and Gallaway[102] contacted a hydrofluoric acid alkylate with hydrofluoric acid in a bomb (Table 10). The 2,3,4- and 2,2,4-trimethylpentanes were most susceptible to disproportionation and the major product was C_9-and-heavier material.

Thermodynamics

Alkylation with acid-type catalysts is very selective in producing certain octanes while other more stable octane isomers are essentially not produced. Equilibrium calculations basis free energy values[75] indicate that at the temperatures employed in hydrofluoric acid and sulfuric acid alkylation, the methylheptanes, 2,5- and 2,2-dimethylhexanes should constitute about 60% of the octane fraction. Yet these isomers are not observed in significant quantities in alkylates. Five of the 18 octane isomers constitute over 90% of the entire octane fraction of alkylates. These principal isomers are 2,4- and 2,3-dimethylhexane and 2,2,4- 2,3,4- and 2,3,3,-trimethylpentane. At thermodynamic equilibrium these would be present in the octane fraction only to the extent of about 14, 1.2, 8.0, 1.1 and 0.8%, respectively.[75]

Although complete octane equilibrium is not observed in catalytic alkylation, Gorin et al.[25] report that the five principal octanes do approach thermodynamic equilibrium with respect to one another by alkylation with each of the three butenes at relatively high temperature and long residence time (Table 8). This is in contrast with the trend towards primary product at low temperature and short contact time. These data support the suggestion of Caesar and Francis[12] that the ultimate composition of alkylate is determined by thermodynamics with the restriction that mechanistic routes are not available for certain components to be formed via processes characterized by high reaction rates.

Variation of Olefin

While many of the same isomers are present in alkylates produced at comparable operating conditions from different olefins, the relative compositions are markedly different (Table 11). In sulfuric acid alkylation, the quality of alkylates produced by combination of isobutane with various olefin[19,54,55] is roughly in the order n-butenes > isobutene > branched pentenes > n-pentenes > propene. However, with hydrofluoric acid as catalyst the butene order appears to be reversed slightly so that isobutene alkylate is higher in quality than alkylates of the n-butenes.[49]

As previously indicated, 1-butene, 2-butene and isobutene yield 2,3-dimethylhexane, 2,3,4- and 2,2,4-trimethylpentane, respectively, as primary product. Yet at temperatures and residence times used commercially, alkylates from 1-butene and 2-butene are very similar in composition, with 1-butene alkylates containing only sightly more dimethylhexanes and 2-butene alkylates containing slightly more 2,3,4-trimethylpentane. While this is true of both sulfuric acid[5,54] and hydrofluoric acid catalysts,[49] use of aluminum chloride yields alkylates with octane fractions containing much more primary product of the respective butenes although less total octanes.[85]

These observations have been explained by the rapid isomerization of 1-and 2-butene via the s-butyl ester.[41,85] The reaction of either of these isomers with hydrofluoric acid or sulfuric acid catalyst results in the following equilibrium mixture:

$$\underset{\text{(Minor)}}{C=C-C-C}+HX \leftrightarrows C-\overset{X}{\underset{|}{C}}-C-C \leftrightarrows \underset{\text{(Major)}}{C-C=C-C}+HX$$

where X is OSO_3H or F. Also, skeletal isomerization of the s-butyl form to the t-butyl form, which would yield isobutene, undoubtedly occurs to some extent. However, this process would be expected to be relatively slow compared with the rate of simple double bond shift. Both 1-butene and 2-butene will, of course, produce alkylates of identical composition if equilibration of the linear butenes occurs prior to olefin addition reactions involved in the alkylation process. Since thermodynamic equilibrium of the linear butenes strongly favors 2-butene over 1-butene at alkylation temperatures,[44] the octane fraction will contain much more trimethylpentanes than dimethylhexanes. Small differences are observed, however, which may be

attributed to reaction of some of the olefinic feed with t-butyl ions before reaction with acid catalyst occurs.

Short contact time alkylation data with hydrofluoric acid catalyst (Table 12) demonstrates that 1-butene is subject to isomerization under alkylation conditions. While the octane products from 1-butene and 2-butene alkylation at short contact time were quite different, virtually equivalent octane products were formed when 1-butene was contacted with HF prior to alkylation. Rapid equilibration of n-butenes under alkylation conditions is also indicated by the alkylation of isobutane with 2-butene in the presence of tritium sulfuric acid.[94] With aluminum chloride as catalyst, however, rapid addition of the t-butyl ion to the olefin occurs while only a small fraction of the n-butene is isomerized via s-butyl chloride formation by reaction with the hydrogen chloride promoter.

There is an important difference in the distribution of the trimethylpentanes produced from sulfuric and hydrofluoric acid catalysts. Alkylates from hydrofluoric acid alkylation contain more 2,2,4-trimethylpentane but less 2,3,3- and 2,3,4-trimethylpentanes.[102] As a result, butene alkylation with hydrofluoric acid yields alkylates of slightly lower quality than those from sulfuric acid alkylation at equal levels of isobutane in reactor effluent.[19]

Isobutane alkylation of branched pentenes yields superior alkylates to those produced from linear pentenes,[19,54,55] since hydrogen transfer reactions occur to a greater extent in the former case to yield larger amounts of trimethylpentanes and isopentane. Large yields of nonanes result from alkylation of linear pentenes. Better pentene alkylates reportedly are produced by fractionation and alkylation of only the light pentene fraction.[19] Pentene alkylates produced by hydrofluoric acid alkylation are reported to be of inferior quality to those produced by sulfuric acid alkylation.[19] While the reason for this difference has not been explained, apparently the higher acidity of sulfuric acid, as discussed in the catalyst section, is effective in promoting the isomerization of linear pentenes to branched pentenes.

Propene forms a stronger bond than the butenes with sulfuric and hydrofluoric acids. Consequently, under some conditions higher temperatures and acidities are required for propene alkylation.[21,41] In one case, alkylation of propene occurred at 86 F with 98% H_2SO_4; while it formed only i-$C_3H_7OSO_3H$, polymers and hydropolymers at 68 F with 97% H_2SO_4. In weaker acids carbonium ions apparently are not formed in sufficient quantity to sustain the desirable alkylation reactions. Butenes are found to be excellent promoters for propene alkylation.[51,77]

Of special significance to propene alkylation is the much higher quality of 2,3-dimethylpentane over that of 2,4-dimethylpentane. The

Table 11. Alkylation of Various Olefin-Isoparaffin Combinations With 96 Wt % H_2SO_4 (c.p.) at 45 F in a Well-Mixed Flow Reactor[a]

Isoparaffin feed	Isobutane							Isopentane		
Olefin feed	Propene[g]	Isobutene	2-Butene	1-Butene	2-Methyl-2-Butene	2-Methyl-1-Butene	2-Pentene	Propene	2-Butene	Isobutene
Feed, vol %										
Olefin	15.9	15.8	16.7	14.9	14.8	16.2	17.2	14.4	18.6	17.1
Isoparaffin	77.0[d]	80.5[d]	80.3[d]	78.9[d]	78.6[d]	81.3[d]	80.6[d]	81.5[e]	78.4[e]	79.8[e]
n-paraffins, C_3-C_5	7.1	3.7	3.0	6.2	6.6	2.5	2.2	4.1	3.0	3.1
Reactor Hydrocarbon [b], vol %										
Product [c]	30.2	25.0	29.8	29.6	40.6	36.9	31.7	36.3	43.7	48.4
Isoparaffin (feed type)	62.9[d]	70.3[d]	65.3[d]	64.5[d]	53.9[d]	58.6[d]	64.6[d]	63.7[e]	51.7[e]	45.3[e]
n-paraffin, C_3-C_5	6.9	4.7	4.9	5.9	5.5	4.5	3.7	7.0	4.6	6.3
Product [c], vol %										
Isobutane	—	—	—	—	—	—	—	7.04	15.83	28.28
Isopentane	3.79	10.01	4.16	4.66	25.27	28.22	19.26	—	—	—
2, 3,-dimethylbutane+methylpentane	4.24	5.21	4.58	4.44	5.35	6.44	1.85	10.24	11.33	15.93
2, 4-dimethylpentane	20.75	3.85	2.37	2.61	2.60	2.15	0.82	2.27	0.82	1.73
2, 3,-dimethylpentane	50.36	2.57	1.38	1.45	1.65	1.55	0.55	4.13	1.51	3.10
2, 2, 4-trimethylpentane	4.43	28.67	30.64	30.49	16.53	17.49	9.84	None	4.50	2.81
Dimethylhexane (DMH)	1.70	9.53	9.02	11.03	6.74	7.33	2.80	53.73[f]	3.02	3.49
2, 3, 3-+2, 3, 4-trimethylpentane	3.70	23.11	41.55	39.08	14.71	14.61	7.91	None	4.00	1.47
2, 2, 5-trimethylhexane	0.87	4.88	1.88	1.77	12.43	9.70	46.55	3.33	34.40	13.22
Other C_9[b]	0.42	1.69	0.53	0.69	3.51	2.86	8.10	3.84	7.56	3.39
C_{10}[b]	5.25	2.49	0.67	0.56	5.43	5.15	1.53	6.72	12.07	16.78
C_{11}[b]	3.73	2.12	0.66	0.65	1.94	1.69	0.10	5.79	3.24	7.48
C_{12}[b]	0.44	5.60	2.55	2.49	3.09	2.37	0.30	2.62	0.69	1.65
C_{13}+[b]	0.32	0.28		0.08	0.74	0.44	0.40	0.29	1.03	0.72

a 47 vol % acid in emulsion; 0.22 olefin (liquid-hourly) space velocity.
b Product analyses by GLC.
c C_4-and-heavier product exclusive of n-paraffins and feed-type isoparaffin.
d Isobutane.
e Isopentane.
f Dimethylhexanes: 2, 5-DMH, 18.9; 2, 4-DMH, 30.7; 2, 3-DMH, 43.6; 3, 4-DMH, 6.8.
g 98 wt % H_2SO_4.
h Estimated from boiling point range.

former is the primary product from isobutane-propene alkylation, while 2,4-dimethylpentane is its principal isomerization product. Thus factors which favor primary product, such as good mixing, high isobutane solubility, low temperature and short contact time, would be expected to play a particularly important role in propene alkylation.

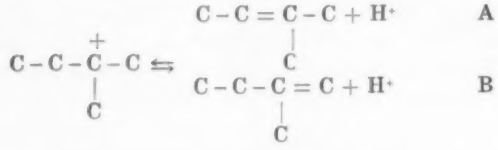
Hydrofluoric acid is reported to produce higher quality propene alkylates than sulfuric acid.[19] This probably results from less 2, 3-dimethylpentane isomerization and the tendency for more hydrogen transfer alkylation to occur with hydrofluoric acid catalyst yielding larger quantities of trimethylpentanes. However, the formation of propane, a low quality product, and increased isobutane consumption are characteristic of hydrofluoric acid alkylation of oropene[69] as expected from hydrogen transfer alkylation of propene.

Dimer and trimer butene polymers, as by-products of butadiene manufacture and as product from hot acid polymerization, have been alkylated with sulfuric acid catalyst with good success,[19,54] yielding alkylates virtually equivalent in composition to those formed from the monomer olefins. In contrast, hydrogenation of the dimer produced material having considerably more 2, 2, 3-trimethylpentane, an excellent component for motor and aviation gasoline, than is produced by alkylation.[19] Hydrogenation of the trimer is undesirable, of course, since dodecanes are the major products.

Ethene forms a stable bond with both hydrofluoric and sulfuric acids with the result that these acids are not effective as catalysts for the alkylation of this olefin. Catalysts reported as effective for ethene alkylation include aluminum chloride,[1,84] hydrofluoric acid containing powdered nickel,[39] alkyl fluoride-boron trifluoride[43] and boron trifluoride-hydrogen fluoride-water.[3] One commercial plant for ethene alkylation using aluminum chloride as catalyst has been described in the literature.[1] Ethene alkylation with isobutane is attractive, since the primary product, 2, 3-dimethylbutane, has a high octane number. Best yields of this hexane isomer are obtained at low temperatures, since increased temperature favors isomerization and increased isopentane production.

Variation of Isoparaffin

Although isopentane is not an attractive isoparaffin for alkylation it is sometimes present in feed streams in large quantities and competes with isobutane for hydride-transfer reactions. Isopentane is, in itself, a good gasoline component and its alkylation normally yields alkylates of inferior quality accompanied by increased catalyst consumption. The primary products expected from isopentane alkylation with ethene and propene are 2, 3-dimethylpentane and 2, 3-dimethylhexane, respectively. The t-amyl carbonium ion formed from isopentane has a greater tendency to lose a proton than the t-butyl carbonium ion because a secondary C-H bond is adjacent to the tertiary carbon containing the positive charge.[43] For the reaction



a product isomer ratio A/B of about 7/1 is reported.[109] Since isopentane is very susceptible to hydrogen transfer alkylation reactions, higher consumption of isoparaffin is observed when isopentane is used instead of isobutane.

Some hydrocarbons compete extensively with isobutane for hydride-ion transfer, and thus isobutane alkylation decreases in favor of less desirable reactions[43] if these components are present in alkylation feed streams. Methylcyclopentane is particularly susceptible to hydride-ion transfer reactions and will react almost completely before isobutane is permitted to react, yielding material that boils well above the usual alkylate range. The relative ease of carbonium-ion formation from certain paraffins of interest[10,43,88] is approximately in the order methylcyclopentane > 2-methylpentane > isopentane > isobutane > methylcyclohexane.

Alkylation Catalysts and Their Physical Properties

Catalysts used commercially for alkylation include sulfuric acid, hydrofluoric acid and aluminum chloride. Factors which have bear-

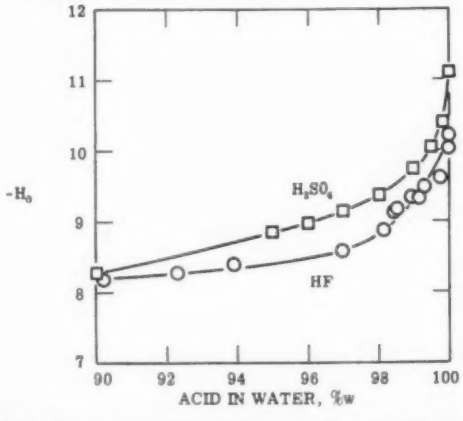


FIG. 3. Hammett acidity function, H_0, of sulfuric and hydrofluoric acids in water at 77 F.[88,68]

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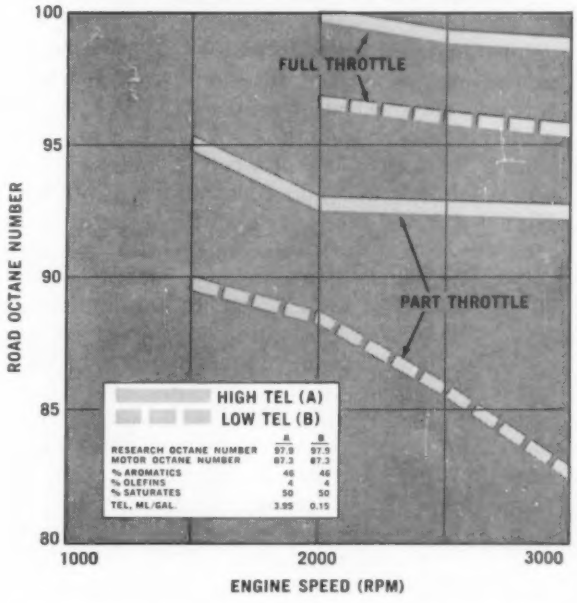

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ing on the overall effectiveness of commercial alkylation catalysts include activity, selectivity for desirable isomers, stability, inertness to deleterious reactions and corrosiveness. Additional considerations for liquid catalysts include solubility of paraffins in catalyst, solubility of catalyst in paraffinic product and, of course, physical properties which relate to fluid dynamics, mass and heat transfer.

Activity

The overall catalyst activity is dependent upon (1) its ability to produce carbonium ions via proton transfer to olefinic molecules and (2) its solubility for isobutane, since the formation of saturated product occurs via hydride-ion transfer from isobutane to alkylate range carbonium ions. The power of an acid to transfer a proton is related to its acidity as given by the Hammett acidity function,[27] defined as H_0. Together, acidity and isobutane solubility determine the average life and concentration of carbonium ions. Such reactions as isomerization and polymerization will be favored by high acidity and low isobutane solubility, while selectivity for primary product is increased by lower acidity[55] and higher isobutane solubility. High isobutane solubility also favors hydrogen transfer alkylation of isobutane. Unfortunately, conditions which reduce acidity, such as water in acid, normally reduce isobutane solubility as well. Consequently, advantages that might be gained by altering acid composition are limited.

Both Hammett acidity function and isobutane solubility (Table 13) of acid are strongly dependent upon its water content and, to a much lesser extent, upon its organic diluent content. Comparison of the Hammett acidity function of sulfuric acid[15,50,68] with that of hydrofluoric acid[37,38] indicates that sulfuric acid is stronger than hydrofluoric acid over the commercial alkylation range of water contents (Fig. 3). However, the solubility of isobutane in hydrofluoric acid[36] is considerably higher than in the sulfuric acid (Table 14). These differences in acid properties can reconcile, to a large extent, the observed differences between alkylates produced by the different catalysts.

In general, hydrofluoric acid, because of its higher isobutane solubility and lower acidity, produces alkylates containing more 2, 2, 4-trimethylpentane in the octane fraction than does sulfuric acid. The high solubility of isobutane in hydrofluoric acid facilitates hydride-ion transfer reactions which form t-butyl carbonium ions. Thus, isobutene formed by the loss of a proton from a t-butyl carbonium ion (reverse of Reaction Type 1) gives rise to 2, 2, 4-trimethylpentane as a primary product when it adds to a t-butyl carbonium ion.

Contact times in the range of 20 to 30 min are used with sulfuric acid and 8 to 20 min with hydrofluoric acid catalyst.[69] Shorter contact times in the latter case are a consequence of more favorable hydride-ion transfer rates. While relatively high temperatures are permissible in the hydrofluoric acid process (75 to 100 F), increased temperature in the sulfuric acid process favors (1) the formation of stable acid soluble compounds which increases catalyst consumption and (2) isomerization and polymerization reactions which reduce alkylate quality. Also, oxidation of olefins and formation of SO_2 occurs at high temperatures in sulfuric acid systems.[40]

Physical Properties

The differences between the physical properties of sulfuric acid and hydrofluoric acid (Table 13) are largely responsible for the important physical differences in the alkylation systems employing these catalysts. The higher

Table 12. Effect of 1-Butene Contact with HF Prior to Alkylation with HF.[25] (Temperature = 68 F; Residence Time = 5 min)

	1-butene		2-butene
Prior contact with HF	No	Yes	No
Octanes, %			
2, 2, 4-TMP	20.7	47.5	48.3
2, 4-DMH	11.0	7.3	6.6
2, 3, 3-+2, 3, 4-TMP	25.0	45.2	45.1
2, 3-DMH	43.3	0	0
	100.0	100.0	100.0

Table 13. Effect of Water on Liquid Solubility of Isobutane in H_2SO_4 at 56 F.

Wt %, H_2SO_4	Wt %, Isobutane in acid
99.5	0.10
98.7	0.070
96.5	0.040

Table 14. Catalyst Properties.[33,36,38,68,93]

	HF	H_2SO_4
Molecular weight	20.01	98.08
Boiling point, F	66.9	554
Freezing point, F	−117	50
98% acid	—	37
Specific gravity	0.99	1.84
Viscosity, cp	0.256 (32 F)	33 (59 F)
Surface tension, dynes/cm	8.1 (80 F)	55 (68 F)
Specific heat, Btu/lb/F	0.84 (30 F)	0.33 (68 F)
Hammett acidity ($-H_0$) at 77 F	10.0	11.1
98% acid at 77 F	8.9	9.4
Dielectric constant	84 (32 F)	114 (68 F)
Liquid solubility, wt %		
i-C_4H_{10} in 100% acid at 80 F	2.7	—
i-C_4H_{10} in 99.5% acid at 56 F	—	0.10
HF in i-C_4H_{10} at 80 F	0.44	—
HF in C_3H_8 at 80 F	0.90	—

viscosity, higher density, higher surface tension and lower isobutane solubility of sulfuric acid make mixing and isobutane transfer a more formidable task than with hydrofluoric acid as catalyst. The consequence of these differences will be covered in the mixing and mass transfer section. The low boiling point and good temperature stability of hydrofluoric acid give rise to another important process difference, viz., catalyst regeneration by distillation. Additionally, other distinctions arise from the high solubility of hydrofluoric acid in hydrocarbons and hydrocarbons in hydrofluoric acid. The effects these differences in physical properties have on operations are covered in the section on reactor systems.

Effects of Acid Composition

The acid loses its utility when its activity is no longer sufficient to maintain carbonium ions at a minimum concentration required for alkylation reactions to occur at rates such that the net accumulation of olefinic material in acid is small. Below this minimum permissible catalyst activity, olefin buildup in acid is rapid and causes rapid activity decline and increased polymerization (acid runaway). Minimum acid consumption is normally obtained by maintaining dropout acid strength slightly above the permissible minimum. Water decreases acid activity about three to five times faster than does acid dilution resulting from organic content.[49] The presence of organic material in sulfuric acid, is, in fact, reported to enhance the solubility of isobutane in the acid and improve the selectivity[23] for primary product. Acid normally becomes spent not by water accumulation but rather by formation of acid-soluble hydrocarbon reaction products.[16,56] This is true, of course, only if feed streams are relatively dry.

A lower titratable acidity can be used for dropout acid if water content of makeup acid is reduced.[35] It is also reported that a lower dropout acidity can be used if the olefinic feed is isobutene rich.[35] There is, however, a disadvantage in using sulfuric acid above 100% titratable acidity since the excess sulfur trioxide undergoes oxidation reactions with hydrocarbons and thereby increases acid consumption rather than reducing it. Makeup acids of 98 to 100 wt % H_2SO_4 and 99.5% HF titratable acidity are reported to give the best results.[23,35,55]

Part 2, appearing in January, will discuss: effect of variables on alkylate properties; mixing and mass transfer; reactor systems; plant operations; instruments and controls; and corrosion. References also will appear in the final part.

About the Authors

C. R. Cupit

J. E. Gwyn

E. C. Jernigan

Dr. Charles R. Cupit, research engineer at Shell Oil Co.'s Houston, Tex., research laboratory, has been in the catalytic process research group doing research in catalysis and reaction mechanisms since November 1959. He has concentrated largely in the field of alkylation. Cupit received his BSChE degree from Mississippi State College and was awarded MSChE and PhD degrees from the University of Illinois. He was an instructor in chemical engineering at the University of Illinois for one year before going with Shell in 1958. He served for about 1½ years in Shell's engineering research group doing research on problems in mass transfer and reaction kinetics. Cupit is a member of AIChE, ACS and Alpha Chi Sigma.

Dr. John E. Gwyn, research engineer at Shell's Houston research laboratory, has concentrated on reactor mechanics, primarily in alkylation since joining the engineering research group in November 1956. A registered professional engineer in the State of Texas, Gwyn holds a BSChE from University of Colorado; and MSChE and PhD degrees from University of Wisconsin. He served as a research assistant and associate for about 2½ years while at the University of Wisconsin, going with Shell as a research engineer in 1955. He is a full member of AIChE and also holds membership in ACS, the Texas and National Societies of Professional Engineers and the Instrument Society of America.

Eric C. Jernigan, research engineer at Shell's Houston research laboratory, has been primarily concerned with catalytic cracking, catalytic reforming and alkylation since joining Shell in 1954. Alkylation experience ranges from process development and engineering studies on commercial units to fundamental studies. His field of interest now includes mathematical techniques as applied to digital computers. Jernigan received a BSChE degree from the University of Alabama in 1954 and is a member of AIChE.

by Arthur J. Makris

How to Save Money With Heat Exchanger Design Variables

Can you switch from original design specifications when you buy heat exchangers and come out money ahead?

The question is difficult to answer because each case is different, but a base case will illustrate design changes that can be made and will compare dollar savings that can be realized.

Estimating Data

Estimating data in the following group of figures is based on exchangers having the same baffle spacing and using average nozzle sizes for each group of exchangers, starting with 4-in. nozzles on the smallest size and gradually building up to 10-in. nozzles on the largest sizes.

Selling prices are based on industry average for 1960 and do not represent the selling prices at one particular shop. Prices are FOB factory.

Fig. 1, 2, 3 and 5 are based on ¾-in. OD by 14 Bwg average welded tubes, SA-214 specifications, installed in an all-steel exchanger fabricated to TEMA "R" standards and ASME code stamped. Fig. 4 can be used with Fig. 1, 2, and 3 to obtain the extra for using ¾ in. OD by 16 Bwg average admiralty tubes and naval rolled brass tubesheets.

Note that by using the required surface the exchanger size can be accurately determined from the respective curves. Size and exchanger type are in standard TEMA designations.

Fig. 1	TEMA type AES, size 29-240, (300 lb/300 lb curve used, no extrapolation) Price	$ 9,000
Fig. 4	Adm tubes extra 0.85/sq ft x 2600 sq ft	2210
	NRB clad tubesheets	640
	Selling price FOB factory	$11,850
	Estimated freight, Houston to Beaumont, Tex. (@2% of selling price)	$ 237
	Selling Price, F/A (100 miles)	$12,087

Freight should be added to the selling prices. However, a quick rough estimate can be made by adding 2% to the selling prices.

Pricing Example

Item 1 — 2600 sq ft, ¾-in. OD by 16 Bwg, 20-ft adm unit, 15/16 in. triangular pitch, shell designed for 300 lb and tubes 150 lb.

Design variables can be handled best if divided into two general categories, mechanical and process.

Mechanical variables are type of construction, tube length and tube pitch.

Process variables are pressure drop, fluid selection, temperature approach, MTD and mass, fouling factors and design pressure.

Type of Construction

Comparison is of 20-ft tube lengths for a floating head exchanger, TEMA Type AES with a U-tube exchanger, TEMA Type AEU. All-steel exchanger, tubes on a 1-in. sq pitch, 300 lb/300 lb.

This is a good example of why it is not a good practice to quote a general savings for using U-tube construction instead of floating head type. The saving varies from approximately 25% for a 10-in. unit to 6% for a 47-in. unit. To obtain percentage of savings for the entire range, a 10-in. unit (155 sq ft), a 23-in.

Gross surface, sq ft	Type AES	Type AEU	Dollar savings	Percent savings
155	$ 2,350	$ 1,770	$ 580	24.7
1250	5,800	4,950	850	14.65
1540	6,750	5,850	900	13.35
5800	18,300	17,200	1,100	6.00
Totals	$33,200	$29,770	$3,430	10.3

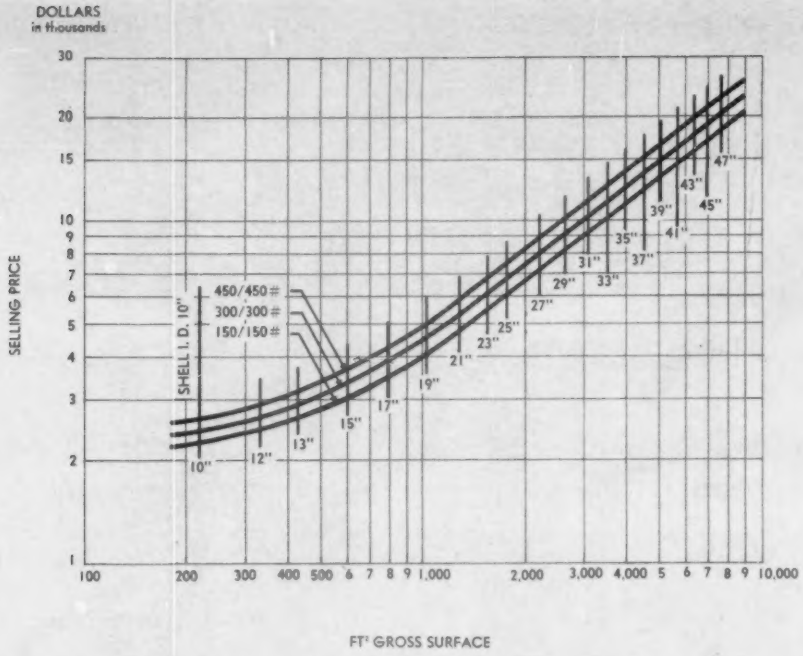


FIG. 1. Floating head type heat exchanger; TEMA Class "R," TEMA Type AES all-steel; tubes welded, ¾ in. OD by 14 Bwg average by 20 ft long, 15/16-in. triangular pitch; one-pass shell and four-pass tubes.

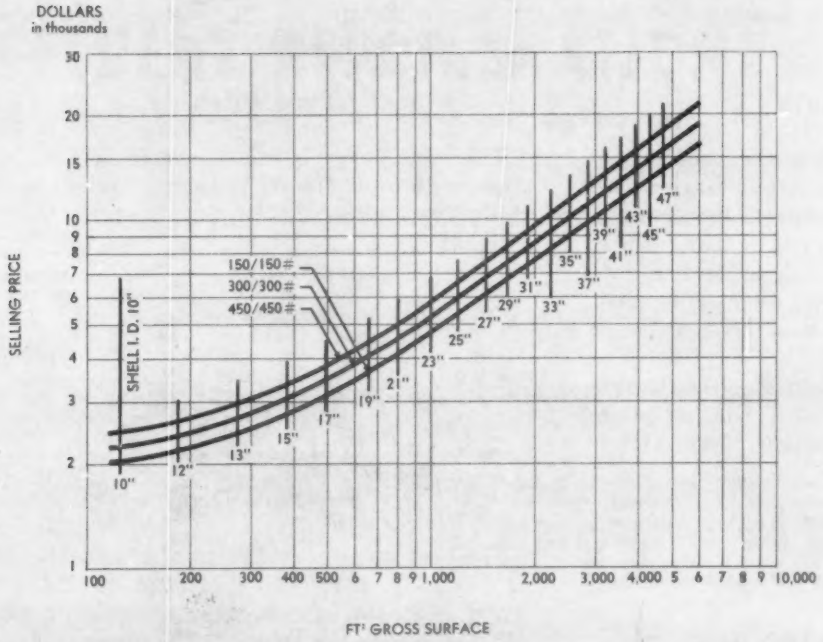


FIG. 2. Floating head type heat exchanger; TEMA Class "R," Type AES all-steel; tubes welded, ¾ in. OD by 14 Bwg average by 16 ft long, 1-in. sq pitch; one-pass shell and four-pass tubes.

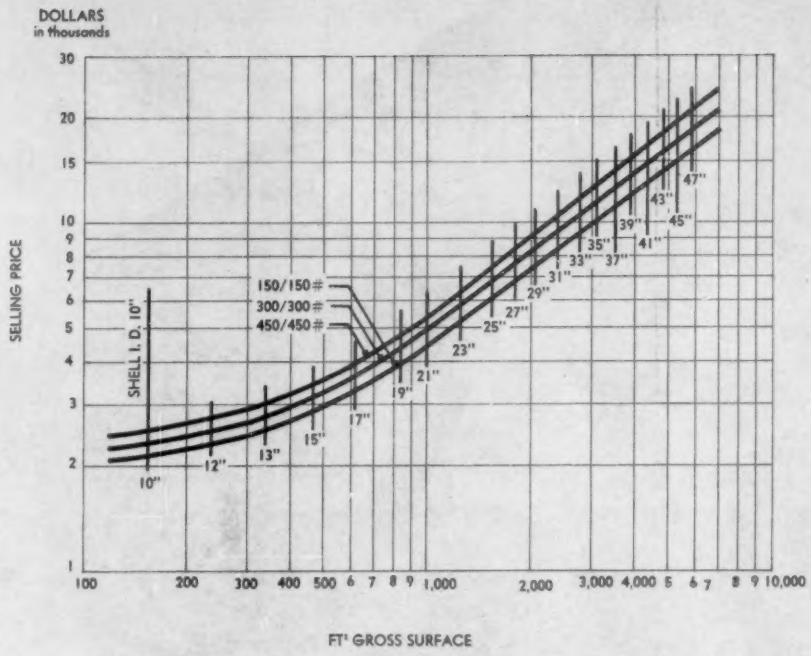


FIG. 8. Floating head type exchanger; TEMA Class "R," TEMA Type AES all-steel; tubes welded, ¾ in. OD by 14 Bwg average by 20 ft long, 1-in. sq pitch; one-pass shell and four-pass tubes.

unit (1500 sq ft), a 25-in. unit (1540 sq ft) and a 47-in. unit (5800 sq ft) were used. The percentage of savings will also vary with design pressure, being greater at pressures above 300 lb design and lower for pressures below 300 lb. For a particular job with all large units the savings might be 10%. For some people who insist on a general figure it is suggested that 10% be used.

Tube Length

The longer the tube length, the more economical the exchanger. This is not so much a case of economics in the construction, but more in the higher design rates realized by using longer tubes. Of course the increase in service rate applies to baffled exchangers such as product coolers and not to isothermal condensers or vaporizers.

The table below is a comparison of 16-ft tubes and 20-ft tubes installed on a 1-in. sq pitch, all-steel floating head exchanger, Type AES.

Gross surface, sq ft	Selling price AES—16 ft	Selling price AES—20 ft	Dollar savings	Percent savings
155	$ 2,350	$ 2,350	$	
1250	6,100	5,800	300	4.92
1540	7,100	6,750	350	4.93
5800	18,300	18,300		
Totals	$33,850	$33,200	$650	1.92

The value for the 20-ft unit is probably a little in error. Remembering that all units have the same baffle spacing, the percentage savings is not indicated in the large unit and the small unit. The average percentage of savings is only 2%. However, when you consider that with the baffled exchanger the increased transfer rates will result in less surface being required, it could be safely assumed that the savings will be approximately 7% for using 20-ft tube lengths instead of 16-ft.

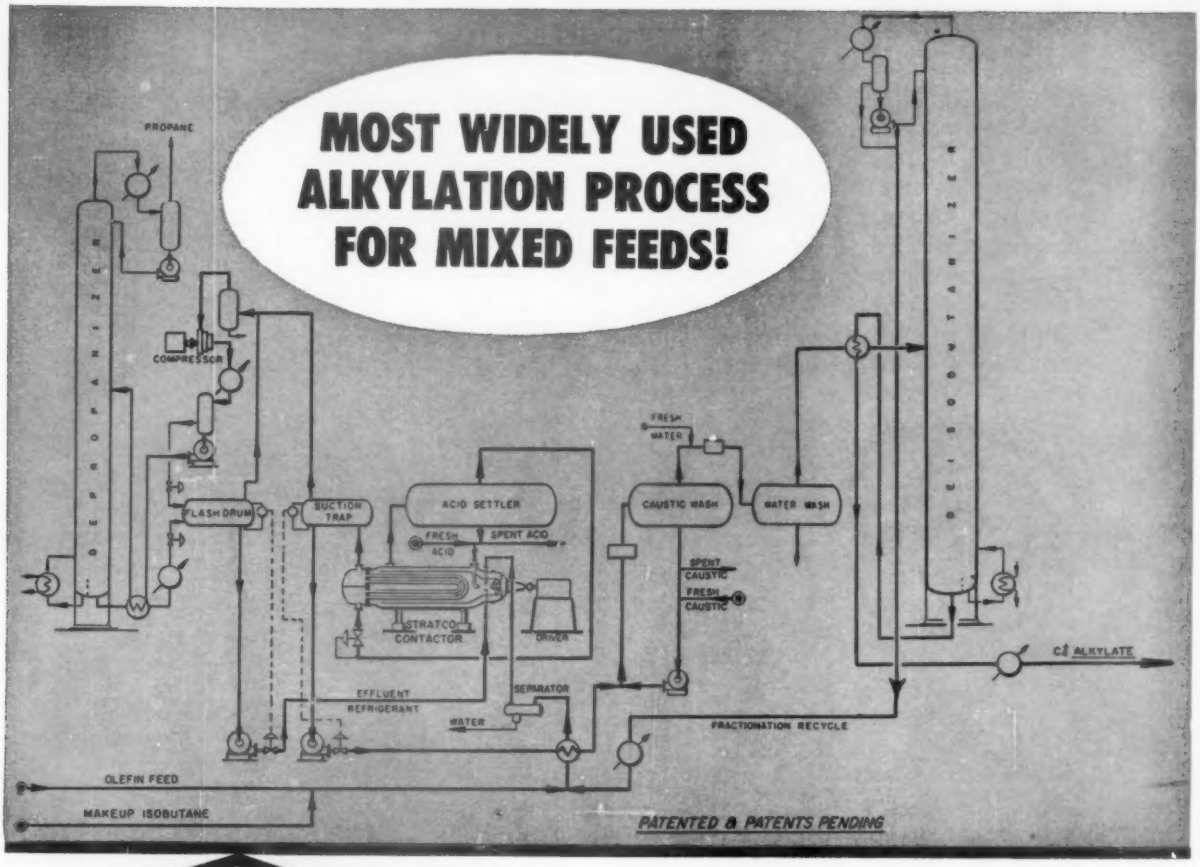
Tube Pitch

The table below is a comparison of 1-in. sq pitch with a 15/16-in. triangular pitch in a 20-ft, Type AES, all-steel, 300 lb unit.

Gross surface, sq ft	Type AES 20 ft 1 in. sq.	Type AES 20 ft 15/16 in. tri.	Dollar savings	Percent savings
155	$2,350	$ 2,270	$ 80	3.4
1250	5,800	5,150	650	11.2
1540	6,750	6,020	730	10.8
5800	18,300	16,600	1,700	9.3
Totals	$33,200	$30,040	$3,160	9.52

Pressure Drop

The heat transfer coefficient of a baffled liquid or vapor is directly proportional to the 0.6 power of the Reynolds number, which is directly proportional to the velocity. The pressure drop is directly proportional to the square of the velocity. From this we can assume that the greater the pressure drop used in the design



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of an exchanger, the higher the transfer rate coefficient.

This does not apply to isothermal condensers or vaporizers. Also the higher the velocities in a heat exchanger, the lower the fouling buildup. To properly evaluate the saving that can be realized from using more pressure drop, the deductions for the increased head must be considered.

Fig. 6 is a curve illustrating service rate vs pressure drop for a 150 lb/150 lb lean oil cooler, with the lean oil in the shell and using admiralty tubes on a 15/16-in. triangular pitch. Total fouling is 0.004.

The example below illustrates the savings that can be realized by using more pressure drop.

Case	Pressure drop per shell	Us Btu/hr-sq ft-F	Q Btu/hr	Corr. MTD F	Surface sq ft	Cost
1	5	94.8	17,280,000	40.8	4460	$16,750
2	10	113.6	17,280,000	40.8	3730	14,400
Difference: 5 lb				Savings:		$ 2,350

This example illustrates how it is possible to save $2350 by using 5 lb more pressure drop on a lean oil cooler. It is generally good practice to allow about 10 lb of pressure drop shell to get the most optimum design. In the above example if the service required three shells it would be good practice to allow 25 to 30 lb pressure drop instead of 5 lb. The process engineer should rough out his surface requirements before stating the pressure drop limitations.

Fluid Selection

The question of which stream to put in the shellside and which stream to put in the tubeside should be given careful consideration. Generally speaking, the fluid with the highest viscosity at the flow temperature will give a higher service rate if put in the shell side. Of course if the process stream is quite corrosive it may be more practical to put it in the tubeside.

In some cases, however, especially if the high viscosity fluid is in viscous flow in the tubeside, the initial cost may be double of what the cost might be if the viscous fluid is exchanged on shellside. For very high pressures it is more economical to put the process fluid on the tubeside and use U-tubes. With a floating head type unit the savings will not be as great.

A good example of fluid selection is as follows:

Viscous fluid, 337,600 lb/hr of 32.8 API crude oil, heated from 100 F to 192 F using 50 lb

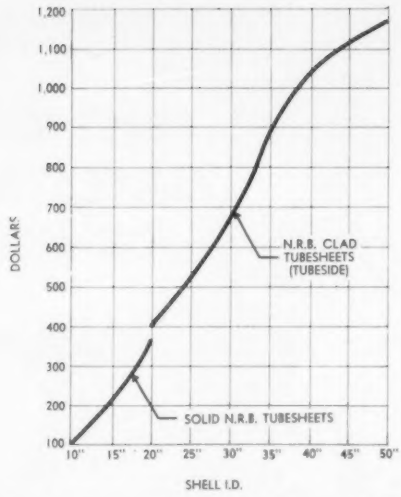

FIG. 4. Extras for solid NRB and NRB clad tubesheets for floating head exchangers (add to selling price from Fig. 1, 2 and 3). For ¾ in. OD by 16 Bwg average admiralty tubes add 85¢ per sq ft surface).

saturated steam. The duty is 16,000,000 Btu/hr and the corrected MTD is 147 F. With crude oil in the tubeside the fluid is in viscous flow, as the viscosity is 6 centipoise at the average temperature and only 8 lb pressure drop is allowed. With the crude oil on the shell side, the tube flow pattern gives a high transfer rate as the crude is constantly being mixed by crossing the tubes.

The table below is a comparison of the service rate for an 8 lb pressure drop. With the crude oil in the shellside and using U-tubes on a 1-in. sq pitch, the service rate is 78.5. With the crude oil in the tubeside using a floating head unit and the tubes on a 15/16-in. triangular pitch, the service rate is only 28.0.

Crude oil, Exchanged in:	Shell	Tubes
Pitch	1-in. sq	15/16-in. tri.
MTD (F)	147	147
U (Btu/hr-sq ft-F)	78.5	28.0
Q (Btu/hr)	16,000,000	16,000,000
Pressure drop	8 lb	8 lb
Effective surface, sq ft	1,390	3,885
Unit type (150 lb 150 lb)	AEU	AES
Unit size	23,240	35,240
Selling price	$5,000	$11,000

Temperature Approach

The most inefficient design results where there are small quantities of fluid and a small MTD, with a large temperature cross, where it is necessary to be in true counter-current flow using many shells in series. This is true of the charge-effluent type exchangers, charge-bottoms exchangers and gas-gas exchangers.

However, at times there are temperature

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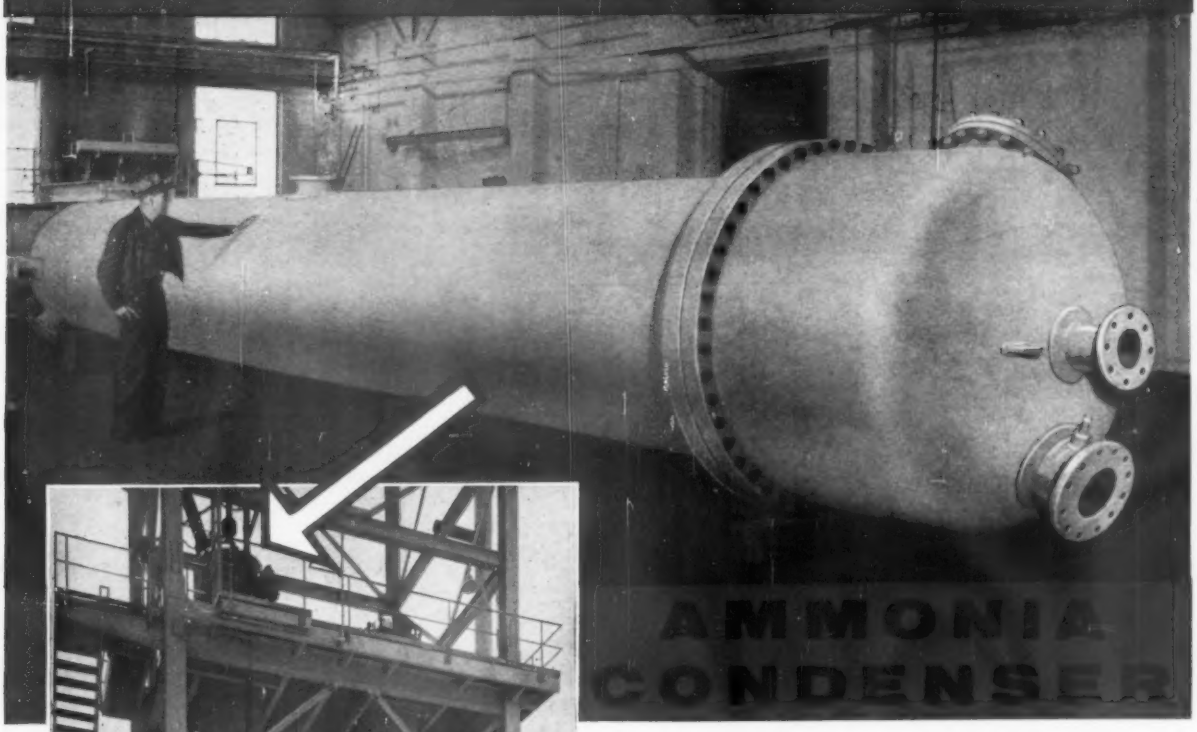

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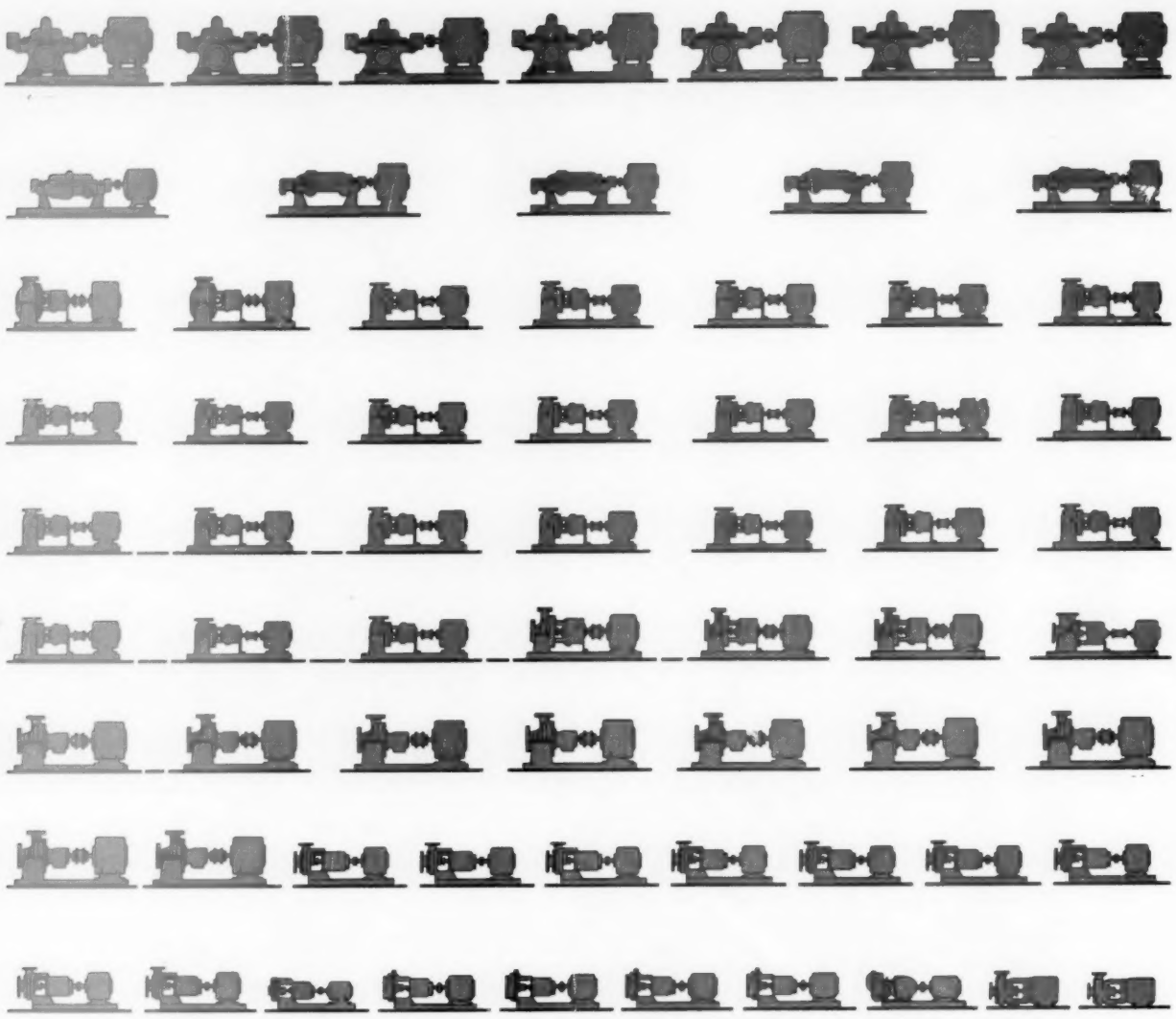
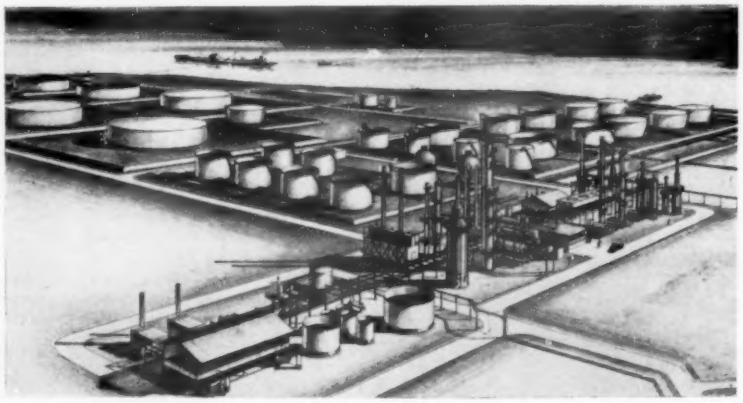
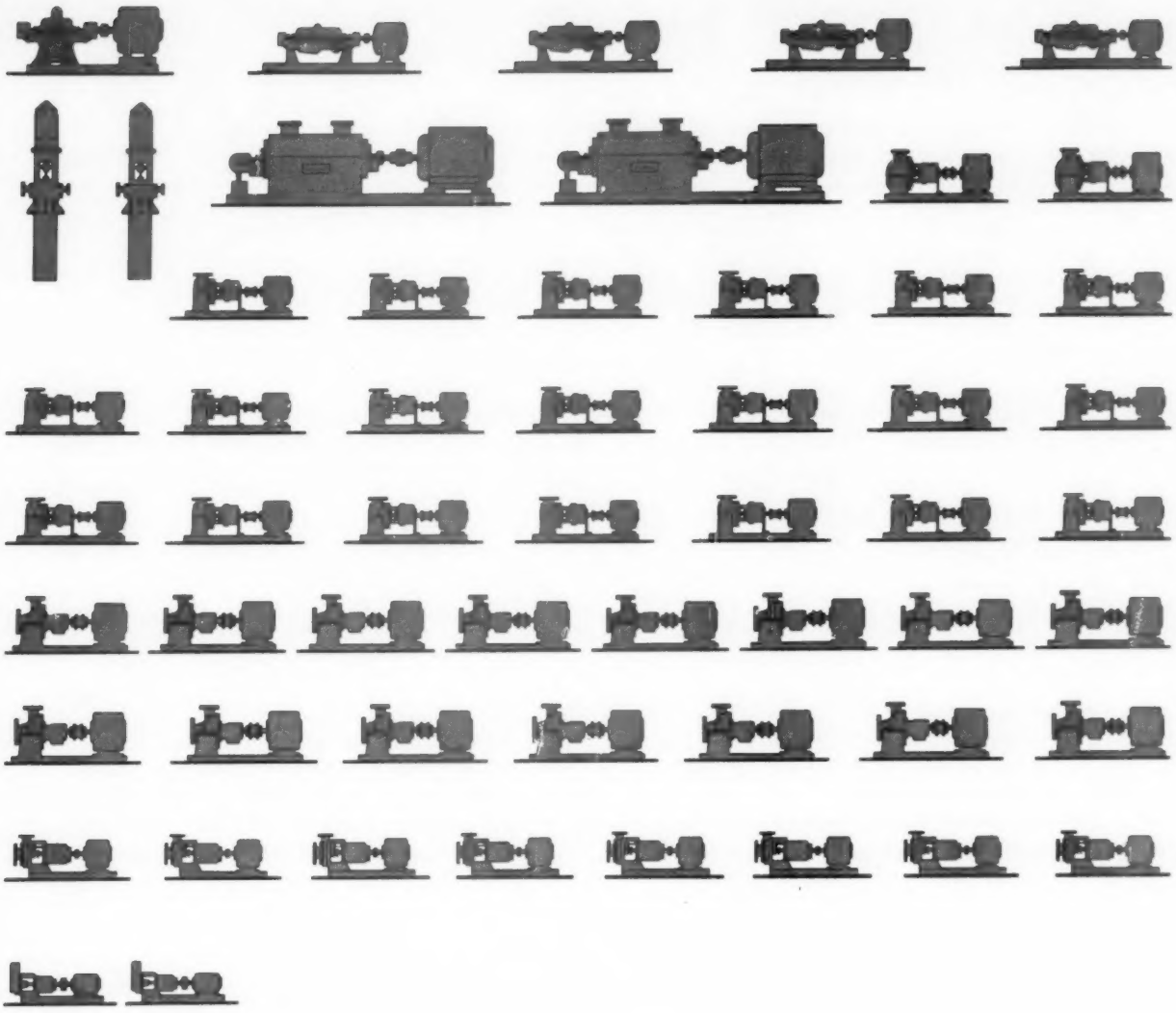


These 122 Ingersoll-Rand centrifugal pumps at new "grass-roots" refinery





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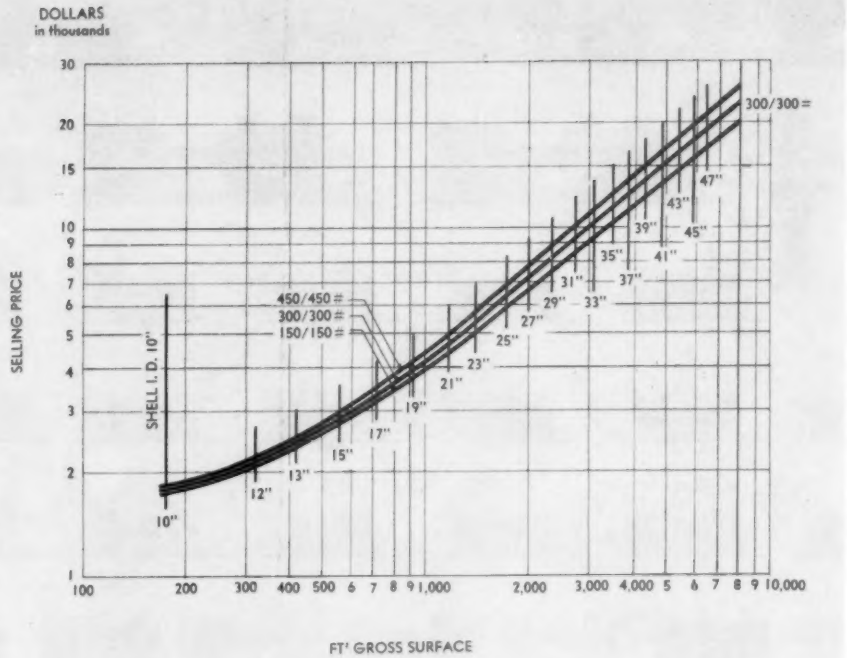

FIG. 5. U-tube type heat exchanger, TEMA Class "R," Type AEU all-steel; tubes welded, ¾ in. OD by 14 Bwg average by 20 ft straight length, 1-in. sq pitch; one-pass shell and four-pass tubes.

crosses on water cooled items where the temperature cross is small. If the product is cooled to a 10 F higher level, one could get by with one shell instead of two shells.

This is illustrated in the example of a product cooler with these specifications:

¾ in. OD by 16 Bwg, Adm Tubes, 15/16-in. triangular pitch, 20 ft long, 150 lb/150 lb.

	Two shells	One shell
Temperature Range	250 to 110 F	250 to 120 F
Water	90 to 120 F	90 to 120 F
Corrected MTD (F)	56.0 F	54.5 F
Duty (Btu/hr)	10,000,000	9,400,000
U (Btu/hr-sq ft-F)	100	100
Surface (Eff. sq ft)	1785	1765
Type	AES	AES
Size	(2) 19-240	(1) 25-240
Selling price	$9940*	$7925

*Includes $180 for stacking.

MTD and Mass

This is the most difficult process design variable to evaluate. A large MTD — in excess of 200 F — generally results in a poorly designed unit. The design problem becomes one of fluid dynamics and pressure drop and not so much of heat transfer. The resulting design is generally a short unit with possible divided flow on the shellside and single pass on the tubeside. The large MTD's should be used with low transfer rate materials while high transfer coefficients material should have low MTD's.

Quite often a poor design results from a large volume of process material, with a short temperature range, being exchanged with a small volume with a long temperature range. An example of this is a high temperature condenser being cooled with water. When this occurs the process designer should consider cooling with air or some other process stream.

Fouling Factors

The selecting of fouling factors should be done carefully. "TEMA Standards," 1959 edition, Section 8, pages 58-62, gives the subject good treatment.

It is interesting to compare fouling vs cost. For a propane condenser being cooled with water one should use a shellside coefficient of 300 for isothermal condensation. If the water

	Coefficient		Resistance
Ht —	1000	Rt —	0.00100
Hs —	300	Rs —	0.00333
U Clean	231	Rc —	0.00433

Includes metal resistance

Uc		220	Rc —	0.00455
Case 1		Case 2		Case 3
Clean resistance	Rc	0.00455		0.00455
Shell fouling	Rf_s	0.00050		0.00100
Tube fouling	Rf_t	0.00100		0.00200
R total		.00605		0.00755
U service (Btu/hr-ft-F)		165		132
Q (Btu/hr)		10,000,000		10,000,000
MTD (F)		20		20
Surface (sq ft)		3030		3800
Type		AES		AES
Size (15/16-in.)		31-240		35-240
Cost (300 lb/150 lb)		$13,380		$16,110

Du Pont *Petroleum Chemicals* News

Number 111 in a series of bulletins for the Petroleum Industry NOVEMBER • DECEMBER 1961

WHICH ANTIKNOCK for standard, compact and economy cars; low or high compression; stick-shift or automatic transmission; 4, 6 or 8 cylinders — straight or V; research, motor or road octane rating? Like today's superhighways, there is a road to almost every destination. The problem is WHICH ONE?

Finding a path through today's antiknock maze

A recent Du Pont study showed one refiner how he could save $19 per 1,000 barrels of regular gasoline and $64 on premium by changing antiknocks.

Another could save $15 on regular and $20 on premium.

The Du Pont studies that made these success stories possible may help YOU *sort out the variables that control antiknock selection today, yielding the octane rating you want at the lowest price possible.*

Wilmington, Del.: The Du Pont Petroleum Laboratory is currently in the midst of a continuing program comparing the antiknock performance of TML, TETRAMIX* lead alkyl mixtures and TEL in a variety of fuels.

These studies have already paid off for a number of refiners, by showing which of the many available antiknocks can do the best job of octane improvement *per dollar spent.*

As refiners are well aware, the performance of the "new" antiknocks varies greatly from fuel to fuel and from engine to engine. Road octane values can differ greatly from Research and Motor octane results. Consequently, a full testing program must be conducted on every fuel before the refiner can safely say, "*This* antiknock is best for my fuels."

*Trade Mark

Du Pont's continuing research provides such assistance.

PROBLEM: How Volatile?

The gasoline you sell to the driver of a stick-shift, 4-cylinder compact may need a different antiknock than that used in an automatic transmission V-8. The Du Pont study has thrown dramatic light on the significance of the differences in volatility of TML, "TETRAMIX" and TEL—and the need for greater volatility in the fuel distribution systems of certain groups of cars. TML and "TETRAMIX" are more volatile than TEL, and have clear-cut advantages in attaining desired Road Octane values in such automobiles.

PROBLEM: What Concentration?

Further results of our studies show that, of the new antiknocks, TML is generally most useful in manual transmission cars with fuels having low front end octane quality. "TETRAMIX" provides advantages over TEL in a variety of fuels, its advantage increasing at higher octane and lead levels and higher aromatic contents.

PROBLEM: How Many Dollars?

Out of all this research comes the practical advantage of learning exactly which antiknock will work best in your fuel on the basis of overall cost. As a rule, the study indicates that TEL is still the most economical antiknock with respect to both Research and Road octane number in most fuels, with "TETRAMIX" proving best for a significant number of fuels and TML winning out in isolated cases.

More Details Available

Our Petroleum Laboratory is prepared to share this study with oil refiners and marketers, and to work individually with you on choosing the most economical antiknock for your fuel. For further details, contact your Du Pont representative.

Computers speed research and results: This computer complex at the Du Pont Petroleum Laboratory is an integral component of many of our basic research studies, such as the effect of various additives on combustion chamber flame speed. By encoding and recording directly from the equipment under test, a great mass of test data is rapidly analyzed. From these data stem experience in the way fuel composition variables affect performance and economy.

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Du Pont *Petroleum Chemicals* News

R. O. BRAENDLE is Head of the Engineering Division, Du Pont Petroleum Laboratory.

Dick joined Du Pont in 1944. One of his early assignments was development research on grease thickeners. In 1950, he moved to the Company's Experimental Station in Wilmington. Two years later, he moved again – this time to market research analyst in the then Technical Section of the Petroleum Chemicals Division. In 1955, Dick became assistant to the Additive Sales Manager and, in 1956, was named Manager, Additives, of our Mid-Continent sales group. A two year stint as Technical Manager, Eastern Region followed in 1958. He came to the Petroleum Lab in early 1960, to head the Chemical Division. Later that same year he assumed his present responsibilities.

A recent indication of the breadth of his current research was contained in the Philadelphia Section-ACS talk he gave last March on "New Lead Antiknock Agents", a report of a continuing research program conducted by his group.

Dick is a graduate of MIT. He and his family live in Wilmington.

New Product Bulletin

describes DMA-4, Du Pont's multifunctional additive.

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- *Rust prevention.* The protective film also protects metal surfaces (engine parts as well as pipelines and storage tanks) from corrosion.
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Du Pont Antiknocks and other Petroleum Additives

OVER

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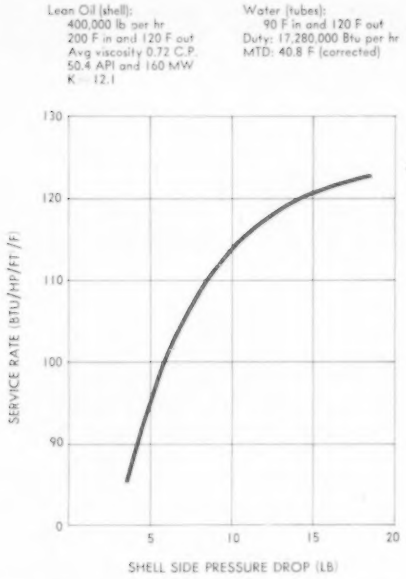

FIG. 6. Lean oil cooler; service rate vs shellside pressure drop; floating head unit, TEMA Type AES; tubes ¾ in. OD by 20 ft long, 15/16-in. triangular tube pitch; one-pass shell and four-pass tubes.

velocity in the tubes is 4 to 5 ft/sec., one could use a tubeside coefficient of 1000.

This example illustrates quite clearly the effect of selecting fouling factors on the cost of a heat exchanger. The effect of fouling on the initial cost is greatest on high U-value exchangers such as steam condensers and becomes very small on low coefficient units such as crude to crude exchangers.

Fouling factors are difficult to determine and should be based on experience. Haphazard guessing can be quite costly. Most heat exchanger complaints that cannot be traced to an error in calculation are resolved back to fouling. The heat exchanger vendor does not and should not recommend fouling factors. The clean rate quoted is your guarantee of what can be calculated and the differences between the service rate and the clean rate is the fouling available.

TEMA standards, in my opinion, are a good guide for selecting fouling factors, but the most reliable source of fouling information is performance data. It is well to be cautious in selecting fouling factors because too small a value will necessitate frequent cleaning of a unit while too large a fouling factor will result in an overdesigned unit which also has its problems.

A good example of this is water cooled items where the surface is too large for the service and the water is either heated to say 150 F or more water is used. Also, pinching down on water causes low water velocities which can cause rapid fouling. A good fouling factor is an accurate fouling factor.

Design Pressure

Normally the highest design pressure should be put in the tubeside of an exchanger and U-tube construction should be used.

Quite often for high pressure streams, or streams where high temperatures are involved, the stream if exchanged on the shellside would require a heavier gage tube than one normally woud consider due to the low value of the collapsing pressure. The ratio of collapsing pressures to bursting pressure is about 2:1. For example a ¾-in. OD by 14 Bwg avg, welded tube, SA-214 in the temperature range of 20 to 650 F is good for an external pressure of 1150 lb while the internal pressure is 2428 lb.

Better Service Possible

These examples are probably extreme cases of how design variables affect cost of heat exchangers. However, the basic principles, if conscientiously applied, will in most cases result in considerable savings without compromising performance and quality.

It is hoped that, by this presentation of the design variables and the effect on the ultimate selling price of heat exchangers, many alternate designs can be eliminated. The practice of designing and pricing alternate selections is wasteful and in most cases unnecessary.

By reducing the number of alternate selections the vendors are required to quote, the buyer of heat exchangers can hope to improve the service on his inquiries.

About the Author

Arthur J. Makris, as sales engineer for Alco Products, Inc., has served in design rating, field service and heat exchanger sales. He received his BS in Chemical Engineering from Newark College of Engineering in 1952. Makris taught electronics during 4½ years in the Air Force, then joined Eastern States Petroleum Corp. (now Signal Oil and Gas Co.) as a process design engineer. He is a member of the Process Heat Exchanger Society.

■

What to Consider

Here is information on a number of special fractionator tray design problems seldom discussed in previous engineering literature.

These include corrections for high pressure operation, designing for the possibility of operating with two liquid phases, the problem of transients, selection of the right bubble cap, use of performance envelope curves and modifications to improve efficiency and capacity.

High Vapor Density

In calculation of the hydraulics of bubble and perforated trays, density of the vapor is neglected when compared with density of the liquid. This procedure is satisfactory until the column conditions approach the critical point or where heavy entrainment is experienced. If a correction is not made for the vapor density in these cases, the trays are apt to prime before the design load is reached.

The following equations, easily derived by use of Bernoulli's theorem, are to be used when vapor density cannot be neglected:

Francis weir formula:

$$h_1 = \left(\frac{Q}{2.98\, l_w}\right)^{2/3} \left(\frac{\rho_l}{\rho_l - \rho_g}\right)^{1/3} \quad . \quad . \quad . \quad (1)$$

Fully notched weir not full of liquid:

$$h_1 = \left(\frac{Q h_n}{1.11\, l_w}\right)^{2/5} \left(\frac{\rho_l}{\rho_l - \rho_g}\right)^{1/5} \quad . \quad . \quad . \quad (2)$$

Fully notched weir completely full of liquid:

$$Q\left(\frac{\rho_l}{\rho_l - \rho_g}\right)^{1/2} = 1.19\, \frac{l_w}{h_n} \left[h_1^{5/2} - (h_1 - h_n)^{5/2}\right] \quad (3)$$

Submerged weir:

$$Q\left(\frac{\rho_l}{\rho_l - \rho_g}\right)^{1/2} = 2.98\, l_w h_5^{1/2} \left[h_5 + 1.5(h_{w_1} + h_1 + \triangle - h_{w_o})\right] \quad . \quad . \quad (4)$$

Liquid gradient[2] (bubble trays):

$$\frac{r^{3/2}\,(1 + 0.25\beta^2)^{1/2}\, Q}{2.4 C_d\, l_1} \left(\frac{\rho_l}{\rho_l - \rho_g}\right)^{1/2} = \triangle^{1/2} \left\{ \triangle \left[3\left(\frac{r}{2} - 1\right) + \frac{2}{1 + 0.25\,\beta^2} \right] + 3r\,[d_o + S(\alpha - 1)] \right\} \quad . \quad . \quad . \quad (5)$$

Liquid gradient[3] (perforated trays):

$$\triangle\left(\frac{\rho_l - \rho_g}{\rho_l}\right) = 0.05\, \frac{(3b + h_f)^2\, \mu\, Q Z_l}{(b h_f)^2\, \rho_l} \quad . \quad (6)$$

Free height in downcomer (bubble tray):

$$F' = t - (2h_1 + h_2 + h_5 + \triangle) - (h_3 + h_4 + 0.5\,\triangle)\left(\frac{\rho_l}{\rho_l - \rho_g}\right) \quad . \quad . \quad (7)$$

Free height in downcomer (perforated tray):

$$F' = t - (h_{w_o} + 2h_1 + h_5 + \triangle) - (h_D + h_4 + 0.5\,\triangle)\left(\frac{\rho_l}{\rho_l - \rho_g}\right) \quad . \quad . \quad (8)$$

Total tray pressure drop (bubble tray):

$$h_t = (h_1 + h_2 + h_3 + 0.5\,\triangle) + (t + h_2 - h_{w_o} - h_1)\,\frac{\rho_g}{\rho_l} \quad . \quad . \quad (9)$$

Total tray pressure drop (perforated tray):

$$h_t = (h_{w_o} + h_D + h_1 + 0.5\,\triangle) + (t - h_{w_o} - h_1)\,\frac{\rho_g}{\rho_l} \quad . \quad . \quad . \quad . \quad (10)$$

Froth height[1]:

$$Z_f\left(\frac{\rho_l - \rho_g}{\rho_l}\right) = 2.53F^2 + 1.89h_{w_o} - 1.6 \quad . \quad (11)$$

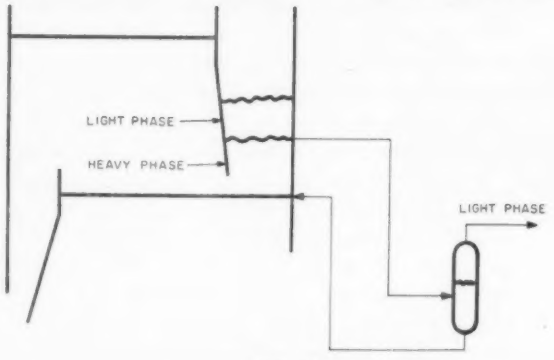

FIG. 7

Part 3, Special Factors by James A. Davies and Dr. Kenneth F. Gordon

in Your Tray Design

Note there are three effects of high vapor density — effect on the individual factors such as head over the wier and liquid gradient, effect on entrainment and effect on the free height in the downcomer. The first two effects tend to decrease the free height in the downcomer rapidly since they increase some individual terms in the equation for the free height. Then, in addition, the equation itself is corrected.

Design for Two Liquid Phases

Special care must be exercised in tray design when there is possibility of operating with two liquid phases. Usually there is enough agitation on the tray to prevent a complete separation of the two phases there. However, it is possible to provide drawoffs for the heavy phase directly on the deck and thus remove an appreciable part of it. This has been done with water from a hydrocarbon system. Drawoffs located at the bottom of the downcomer, of course, would preferentially draw off the heavy phase first.

There are two dangerous situations present when operating with two liquid phases:

1. An unexpected, small amount of light phase may appear and segregate in the downcomer. It will be the continuous phase from the liquid level down to the bottom of the downflow baffle. Since its gravity is lighter than that of the heavy phase which was the basis used in the tray design, the liquid level in the downcomer will be higher than with only the normal heavy phase present and may be sufficiently high to cause flooding.

If there is possibility of a second light phase occurring, the flooding limit should be checked to establish existence only of light liquid in the downcomer and heavy liquid in the bubbling area. A light phase drawoff could be provided in the downcomer above the bottom of the downcomer baffle. The drawoff consists of a line going to a settling drum with an equalizing line back to the downcomer (see Fig. 7).

The drawoff line should be low enough to be below the calculated clear liquid level in the downcomer, calculated as though only heavy phase were present. If all light phase production is removed, the heavy phase will rise to the level of the drawoff nozzle.

2. A small amount of a heavy phase some-

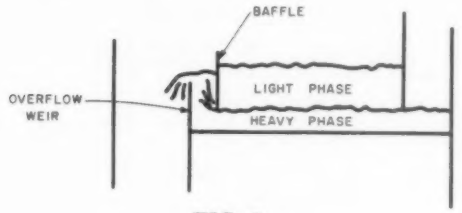

FIG. 8a

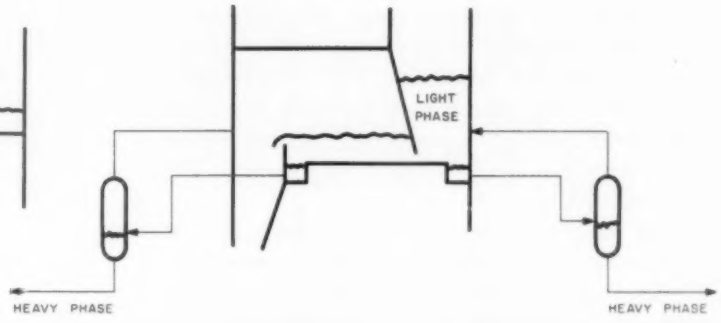

FIG. 8b

times occurs. While this will not usually cause flooding, it will be the principal liquid on the deck. It will decrease tray efficiency by reducing rate of transfer from the vapor to the dispersed light phase. It tends to increase tray pressure drop, too. Also, in the case of water forming in a hydrocarbon system, it will cause the tower to become erratic or badly upset.

In any system in which there are two liquid phases being continually mixed and separated there will be some fluctuation in flow rates of the individual phases. Since the latent heat per liquid volume for water is much higher than for hydrocarbon, the tower will be operating under continually changing local reflux loads. It is recommended always to draw the water off.

Fig. 8 shows two schemes. To reduce effect of the heavy phase on tray efficiency and pressure drop, a baffle could be provided in front of the overflow weir as shown on the sketch.

Problem of Transients

Trays rarely operate under the steady state flow conditions assumed in their design. This is especially true when the fractionator is controlled by automatic instruments. Automatic instruments are continuously changing loads in seeking to keep the load close to the set point. These changing loads will result in a lowering of tray efficiency and, if the changes are of sufficient magnitude, will result in a cyclic condition of the tower.

Some towers have been observed to flood or prime in a cyclical manner or to dump liquid through the risers cyclically. A reboiler taking liquid from the trap pan at the bottom tray will frequently induce a cycle of the latter kind since a dump will be followed by a period of vapor deficiency from the reboiler which in turn causes another dump.

It has also been observed that these cyclical changes do not have to be large in magnitude if they are sufficiently rapid to cause seriously upset conditions on the trays. For instance, the tower could be operating well below the flood point yet it can flood even though the maximum rates during a cycle do not even approach the flooding rates.

The one insidious thing about these cycling conditions is that they frequently go unnoticed. Unless a careful tray efficiency determination is made or a sensitive recording instrument is located at the point where the cycle results in the maximum changes in tray conditions, there would be nothing to indicate a mildly cycling column.

Very little is known about preventing or dampening column cycles. Some tray designers deliberately attempt to design a tray that will tend to dampen out fluctuations without being upset by them. For instance, a high dry pressure drop in perforated trays consistent with the allowable column pressure drop will tend to dampen out vapor fluctuations.

A brief description of how to attempt to design a bubble cap to dampen fluctuations is given under "Bubble Cap Design." However, the designer is groping in the dark since there is no data available that allows him to design quantitatively a tray to dampen out certain severe fluctuations. He now must go on hunch and empiricism and with the hope he has done some good.

It is hoped that the field of transients will be investigated in the near future. Some start already has been made in the area of systems analysis where the effects of changes in rates and compositions of the separation are being studied. However, to the authors' knowledge,

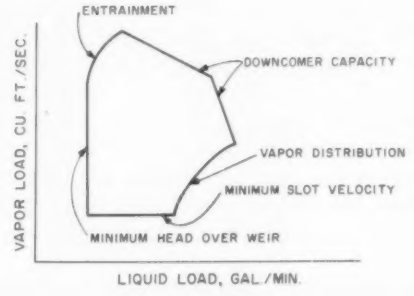

FIG. 9

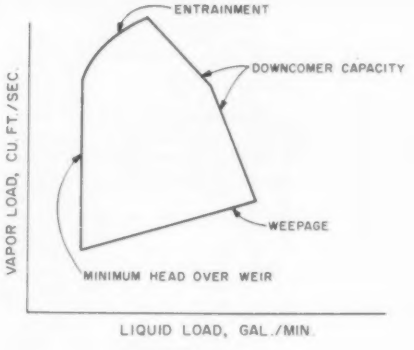

FIG. 10

only a little work is being carried out specifically to investigate the effect of transients on fractionating equipment capacity in this country although the American Institute of Chemical Engineers, through its research committee, plans to study the process dynamics of complete distillation systems and their component parts.

In tray design the effect of the acceleration or deceleration of the vapor passing through a tray needs to be determined. The changes in vapor rate add another head term to Bernoulli's equation as follows:

$$z + \frac{u^2}{2g} + \int \frac{1}{\rho}\frac{\partial p}{\partial x}dx + \frac{1}{g}\int \frac{\partial u}{\partial \theta} dx - f = \text{constant} \quad . \quad . \quad . \quad . \quad (12)$$

The next to the last term on the left side can be either positive or negative. An acceleration is positive and tends to blow the liquid away from the caps or perforations. A deceleration, being negative, will tend to prevent vapor from passing. At some caps and perforations on a tray, a liquid will run back through (i.e. dump).

There is considerably more entrainment in columns which exhibit vapor fluctuations. This effect also needs to be studied.

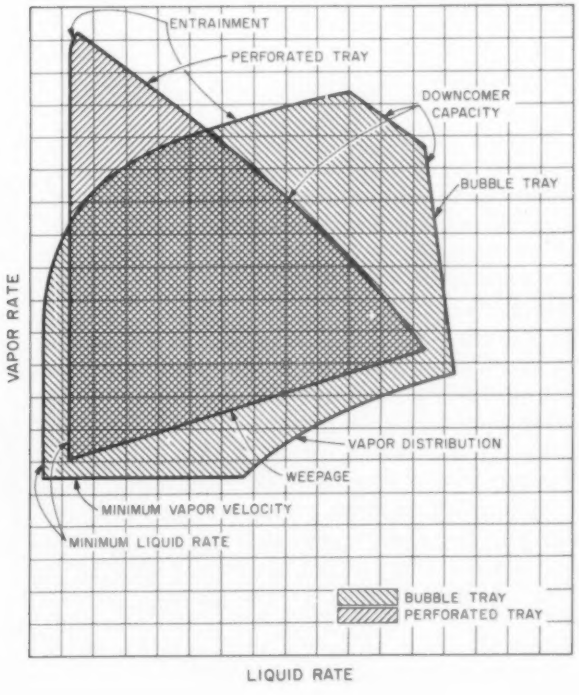

FIG. 11

Bubble Cap Design

Bubble caps come in numerous sizes and shapes and reflect the whims and imagination of the designer. In the AIChE's recent research program[1] a number of caps of various kinds of layouts were investigated, and these conclusions resulted:

1. Small caps give slightly higher point efficiencies than large caps.
2. Small caps give less back mixing than large caps.
3. Small caps give less entrainment than large caps.
4. Large cap spacing is preferable.
5. High slot velocities give a slight improvement.
6. There is no difference in efficiency with low or high skirt clearances.
7. None of the above effects are appreciable and in general cap design has little to do with the tray efficiency.

Small caps are more costly than large caps, but allow a more flexible design, especially for the smaller columns. Tunnel caps usually result in caps of several sizes being required on each tray, especially in the smaller column diameters. Round caps lend themselves more easily to standardization and ease of fabrication. The optimum size is about 4½ in.

The main consideration after the size is set is to determine lengths of slots and height of the riser. These should be set by pressure drop and transient considerations. A low pressure drop is desirable, but a good operating cap under transient conditions is also desirable.

At low vapor rates the vapor tends to pulsate. This is thought to be brought about by use of shallow slots that are flat at the top. A highly tapered slot will offer a smaller area at low vapor rates and more pressure drop than will a short rectangular slot; hence, there will be less tendency to fluctuate. This means the slots should be over 1 in. in height and usually 1½ in. high.

To minimize dumping it is desirable to have the top of the riser as high above the top of the

slots as practical. It is recommended that this distance be kept at a minimum of ½ in. with 1 in. desirable for the larger caps. The skirt height will be dependent on amount of sediment expected on the tray deck and will vary from zero to 1½ in.

Performance Envelope Curves

The limits of performance for any given bubble tray may be expressed by a performance envelope curve, Fig. 9. The limiting boundary lines are self-explanatory and are described by the appropriate equations and curves listed or referred to in Parts 1 and 2. Flooding occurs to the right of the line marked "downcomer capacity" and is determined by Fig. 3 of Part 1. Poor vapor distribution and generally unsatisfactory operation occurs to the right of the line marked "vapor distribution," which is determined by the vapor distribution ratio, $\triangle$ /h_s.

Operation inside the envelope is satisfactory, although the maximum efficiency may not be obtained throughout the zone. A tray designer will design a tray so that all anticipated operating conditions will lie inside the envelope curve. By choosing different downcomer areas and bubbling areas for a column of a fixed diameter, the envelope curve can be shifted. For instance, the curve may be shifted to the right and downwards by allowing for larger downcomer area and less bubbling area. A minimum head of ¼ in. is taken over the weir to insure proper liquid distribution, even though the tray may not be quite level.

A similar envelope curve is possible for perforated trays (see Fig. 10). Here the weepage line takes the place of the minimum slot velocity and vapor distribution. In some unusual cases it is possible to have a vapor distribution limitation in addition to the weepage limitation. A minimum of ½ in. over the weir is recommended for perforated trays since the weir alone determines the liquid distribution of the trays. On bubble trays the bubble caps help the distribution.

In general, when comparing a bubble tray performance with a perforated tray performance, the weepage line is higher than the vapor distribution line. The downcomer capacity line for bubble trays takes in lower residence times and lower minimum free height than is still recommended for perforated trays. This results in a little more downcomer capacity for bubble trays than for perforated trays. However, since bubble trays have more entrainment than perforated trays, the entrainment line for bubble trays reduces their capacity compared with perforated trays. A comparison of bubble tray and perforated tray capacity is shown in Fig. 11. Note the perforated tray has about as much flexibility as the bubble tray. This example is for a depropanizer and both types of trays have the same tower diameter and downcomer area.

In testing a tray, particularly in the laboratory, various vapor and liquid loads are put on the tray at a fixed vapor-to-liquid ratio, usually at total reflux, and the efficiency is determined. Then the particular tray is compared with a tray of another design that has been tested similarly. A plot similar to Fig. 12 is obtained.

It is obvious from the plot that Tray A is superior to Tray B from an efficiency viewpoint at the particular ratio of liquid and vapor rates. However, Tray B could very well be the better tray. Fig. 13 shows the envelope curves for these two trays and indicates Tray A has a higher vapor and a lower liquid capacity than Tray B. A test at L/V = 1 would cover only a small part of the operability zone of Tray B but a larger part for Tray A.

The conclusion is that this type of test is unfair, but unfortunately it is the one usually made. To evaluate a tray properly, at least three different ratios of vapor to liquid should be used — one at total reflux, a second at a vapor-to-liquid ratio higher than unity to cover a fractionating section condition, and a third at a ratio lower than one to cover a stripping section condition.

Improving Efficiency and Capacity

While a proper tray design will result in the optimum design capacity for a given set of conditions that have to be met, frequently trays either do not come up to expectations in operation or the operation is for a condition outside of the scope of the original design. In this case the designer must collect sufficient data to analyze the situation and decide whether there is something wrong with the trays other than that they are not being operated at the design conditions. After the trays have been checked at the operating conditions, the designer then makes his recommendations as to modifications.

In some cases there will be no apparent reason why trays show poor operation. Some reasons for low efficiencies are given in the Bubble Tray Design Manual.[1] In the authors' experience the usual reasons for either low efficiency or low capacity, other than operating outside of the envelope curve, have been:

1. Transients. Cycling vapor and liquid rates as discussed above will result in a lowering of the efficiency and a decrease in the tray capacity. Sufficient observations are required to determine whether cycling is present.

2. Liquid and vapor by-passing. Liquid by-passing is caused primarily by improperly sized and located weep holes and improperly installed trays that allow liquid to weep through trays, particularly ones in vacuum service. Pressure operation in general will result in vapor passing up through weep and other holes in the tray. Of course, weep holes in downcomer sections should be avoided as they may pass vapor resulting in a decreased downcomer capacity.

Vapor by-passing is the more serious problem, because sites where it can occur are harder to locate. Places where liquid can by-pass are uncovered when a tray is tested for tightness with water. The most serious location, and unfortunately one of the usual locations for vapor by-passing, is into the downcomer. Whenever vapor gets into the downcomer, reduced capacity results. It is difficult to fabricate a tray with proper sealing elements around the overflow weir and downcomer baffle. Great care should be taken in checking the fabricator's drawings and the final installation so that no possibility of vapor leakage into the downcomer section from the tray below exists.

3. Improper feed installations. An all-liquid feed should not come into the downcomer section unless it is colder than the downflow liquid. Otherwise, some vaporization will take place in the downcomer. If the feed is hotter than the tray liquid, it should be introduced into the center of the tray away from the overflow weir and the downcomer baffle. Some vapor and liquid disengagement should be accomplished before allowing feed to spill onto the tray. At no time should hot feed be directed towards the downcomer baffle, as this might cause vaporization on the other side of the baffle in the downcomer section. If the feed liquid is colder than the tray liquid, it can be introduced into the downcomer section, but care must be exercised that no feed vapor is introduced as well.

A feed or reflux with a high entering velocity may impinge against a cap and cause the cap to backtrap. Baffles should be provided to prevent high velocity impingement.

Reboiler outlets are frequently directed towards the downcomer baffle or seal pan below the bottom tray. This will cause vaporization in the downcomer section. Also, high reboiler velocities into towers may depress the liquid in the seal pan and break the liquid seal, causing the downcomer to pass vapor.

4. Multiple-pass trays. Two pass or multiple-pass trays are resorted to where large liquid loads are present. However, it is felt they are too frequently used and should be avoided

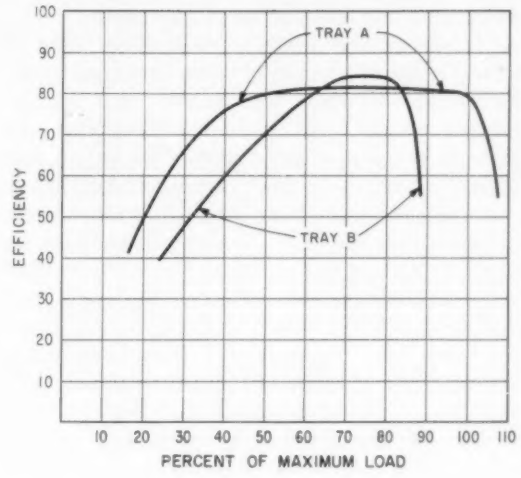

FIG. 12

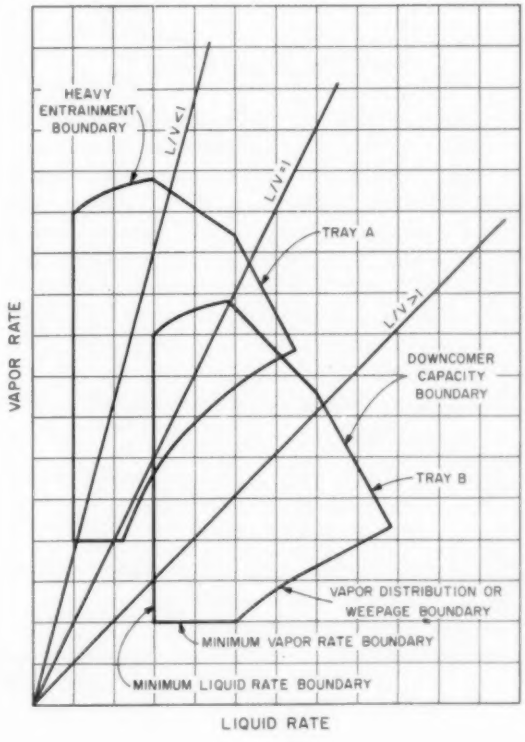

FIG. 13

wherever possible. Multiple-pass trays give lower intrinsic efficiencies than what one should expect.[1] It is the authors' feeling that these lower efficiencies usually found in two-pass trays result from the inability to split the feed equally between the halves of the tower.

A mathematical analysis will show that if the feed is not split equally, a serious liquid maldistribution between the halves will be established which will persist throughout the stripping section of the tower. The vapor will eventually distribute itself evenly in the tower but the liquid never does unless it is introduced in a center downcomer. If pressure equalizing ports are provided to equalize pressure on each side of the center downcomer, the liquid will tend to distribute itself evenly a few trays below the feed. However, if these equalizing ports are not present, an unequal vapor feed will induce an unequal liquid distribution. This will persist throughout the stripping section although the vapor quickly distributes itself evenly once inside the tower.

Also, even with the feed evenly distributed, the liquid will become maldistributed if the inlet conditions result in vaporization occurring in the downcomers. Too, transients probably will result in maldistribution of liquid.

Dealing With Foam

If foamy liquids are to be handled on a tray, the usual practice is to increase the downcomer size. For instance, if downcomer residence is used to size the downcomer, the minimum time may be doubled for very foamy liquids. Foaminess will also necessitate reducing the design bubbling F-factor to prevent priming. With no data available to adequately determine effect of foaminess on tray sizing, it is necessary to be very conservative in tray design for liquids known to have strong tendency to foam.

Nomenclature

b = average liquid flow width, feet.

C_f = liquid gradient factor.[2]

d_a = total flowing clear liquid depth adjacent to overflow weir, inches.

F = F-factor, defined as $u_G\sqrt{\rho_g}$.

F' = free height in downcomer (distance from top of overflow weir to clear liquid level in downcomer), inches.

f = frictional head.

g = gravity.

h_D = dry tray pressure drop, inches of hot clear liquid.

h_f = flowing submergence, inches of hot clear liquid.

h_n = depth of notches in weirs, inches.

h_t = total vapor pressure drop between trays, inches of hot clear liquid.

h_{w_i} = inlet weir height, inches.

h_{w_o} = overflow weir height (measured to the bottom of the notches), inches.

h_1 = clear liquid crest over overflow weir, inches.

h_2 = static submergence (difference in height of overflow weir and the top of the bubble cap slots), inches.

h_3 = pressure drop through caps and risers for wet tray (assuming vapor is evenly distributed among the caps and risers), inches of hot clear liquid.

h_4 = liquid pressure drop through downcomer constriction area, inches of hot clear liquid.

h_5 = additional liquid head caused by inlet weir, inches.

l_w = weir length (measured straight across top of weirs, whether notched or not), inches.

l_1 = total free space between caps normal to liquid flow (average of various rows), inches.

l_2 = total free space between risers normal to liquid flow (average of various rows), inches.

p = total pressure.

Q = clear liquid rate (includes entrained liquid), gpm.

r = number of rows of caps perpendicular to liquid flow.

s = cap skirt clearance (distance of bottom edge of caps above tray deck), inches.

t = tray spacing, inches.

u = vapor velocity.

u_G = vapor velocity in bubbling area, ft per sec.

x = distance along path.

Z_f = visual froth height, inches.

Z_l = distance between the inlet and outlet weirs, feet.

z = elevation.

$\alpha = l_2/l_1$.

β = average of ratios of minimum distances between adjacent caps in the same row and in adjacent row and the same between adjacent risers[2].

$\triangle$ = liquid gradient, inches.

θ = time.

μ = viscosity of the clear liquid, centipoises.

ρ = gas density.

ρ_g = gas density, lb per cu ft.

ρ_l = liquid density, lb per cu ft.

References

1. AIChE, BUBBLE TRAY DESIGN MANUAL, New York, 1958.

2. Davies, J. A., PET. REF., 29, August, 93, September, 121, (1950).

3. Hughmark, G. A., and O'Connell, H. E., CHEM. ENG. PROG., 53, 127, (1957).

James A. Davies is chief process design engineer for Texaco Inc., Houston. Dr. Kenneth F. Gordon is associate professor of chemical engineering at University of Michigan, Ann Arbor.

■

HPI Equipment

Twin-Chamber Gas/Air Dryer

Something new in the drying of air, nitrogen and/or inert gases is the reactivation of the adsorbent without use of heating energy or cooling water. This is the outstanding feature of the twin-chamber, one-vessel Cal-Vac Hydryer which is described in a new bulletin. It reduces operating costs and weight, makes it more compact and eliminates danger of corrosion and need for insulation. The fully automatic Cal-Vac will attain dewpoints as low as -100 F. It is available in 12 standard units for drying air and other gases up to 150 psig and 120 F inlet conditions. *J. F. Pritchard & Co. of California.*

Circle number (41) on reply card

Kelloggram On Alkylation Unit

Design and execution of a 1100-bpd Cascade sulfuric acid alkylation unit at United Refining Co.'s Warren, Pa., refinery are described in an 8-page, illustrated Kelloggram. Flowsheet of the Cascade process shows operation for both butylene alkylate and mixed C_3-C_4 alkylate operation. Product recovery and feed treating systems are described. A chart gives acid consumption rates required to achieve various octane ratings for a range of mixed alkylates. *The M. W. Kellogg Co.*

Circle number (42) on reply card

Two-Stage Stainless Seals

New stainless steel and Viton A seal for fluid systems operating between – 65 F and + 500 F and up to 10,000 psi is subject of a new bulletin. It describes construction of the composite V-rings and gives technical data on materials with dimensions and standard sizes. Help in ordering is also included. *Pall Corp.*

Circle number (43) on reply card

Valve for Cryogenic Service

Series V-41600, high-flow, floating-seal valve, developed especially for cryogenic service, features a leak-proof design in which all external joints are inert arc-welded by a special process. Flow of fluid media contacts only all-metal surfaces. Electrical specifications are 18 to 30 v d-c. Maximum inrush is 7.5 amp at 30 v d-c at 72 F. Holding is 2 amp maximum at 30 v d-c at 72 F. Standard series withstands media temperatures of – 320 F to + 140 F; ambient of – 65 F to + 140 F. Maximum operating pressure is 50 psi. *Valcor Engineering Corp.*

Circle number (44) on reply card

Treating Boiler Feedwater

New 24-page Bulletin 30, "An Introduction to Boiler Feedwater Treatment," tells why water treatment is needed and how impurities are removed from water. The appendix contains data used in water chemistry, what various water analyses mean, and pertinent conversion factors. *Nalco Chemical Co.*

Circle number (45) on reply card

Teflon Treated Packing

New soft packing for solvent and mild acid or mild alkali service is a plastallic product featuring a powdered Teflon-asbestos fiber core and a single, non-metallic braided asbestos yarn jacket, thoroughly impregnated with Teflon suspensoid. A plastallic core permits use of this general service packing as a valve stem ring where out-of-square sizes are required. Sizes of $\frac{1}{8}$ through 1 in. in $\frac{1}{16}$-in. increments are available. *Garlock Inc.*

Circle number (46) on reply card

Spherical Plastic Tank

Low-cost spherical tank, called Chemisphere, features resistance to corrosion and high strength. Chemical resistance is provided by the use of glass-reinforced bisphenol A polyester. Suitable as a processing or storage unit for the petroleum and chemical industries, the tank is available in diameters of 6 ft (847 gal) and 8 ft (2009 gal). Its weight is about 1/7 that of a comparable stainless steel unit. *Justin Enterprises, Inc.*

Circle number (47) on reply card

Transducer Data

Improved Model 176 Teledyne pressure transducer that senses dynamic pressures in high speed chemical reactions and tests of rocket, jet or turbine engines is described in a bulletin and a service manual. Bulletin provides specifications, prices and descriptive information. The 8-page manual gives instructions for field servicing. Procedures to be followed in opening a transducer for cleaning the pressure cavity or replacing a diaphragm-seal combination are presented in illustration and caption form. Reassembly steps are similarly pictured and described. Methods of calibration are detailed. *Taber Instrument Corp.*

Circle number (48) on reply card

Stainless Steel Tubing

New 12-page booklet gives detailed information on the use of stainless steel tubing in condensers, including performance data, applications in various types of water, and fabrication of the tubes. Charts and photographs, as well as historical background, are also included. *Allegheny Ludlum Steel Corp.*

Circle number (49) on reply card

Self-Priming Petroleum Pumps

New line of self-priming pumps, designed for handling petroleum in bulk storage plants, consists of 11 models with suction sizes from 3 to 6 in. Units have capacities ranging from 100 to over 1200 gpm of liquid and are powered by either long or close-coupled electric motors. Design provides low maintenance and simple field servicing. Pump efficiencies are as high as 74%. *Marlow Pumps, Div. of Bell & Gossett Co.*

Circle number (50) on reply card

Special Purpose Computers

Complete line of special purpose analog computers for fully automatic on-line control of various industrial processes is assembled from stock, solid-state modular designed components. Computers can be used

. . . one of a series presented by Western Supply Company, Tulsa, to improve the "I. Q."* of engineers . . .
(*"Income Quotient")

TRAIN YOURSELF AND OTHERS IN SUPERVISORY TECHNIQUES FOR PROFESSIONAL ADVANCEMENT

Popular thinking on any subject is often like a pendulum, swinging forward in sheer exhilaration over an exciting idea, then backward to a cynical attitude against it. Years ago, health columnists extolled the nutritive qualities of spinach. Shortly thereafter, it was equally popular to decry spinach as an over-glamorized weed.

This vacillation springs from the efforts of spokesmen to capture interest, and the tendency of many people, like wild creatures in the forest, to give attention to whatever is moving regardless of the direction. That is why it sometimes seems that the more preposterous an idea the more credence it receives.

After World War II, supervisor and management development became extremely popular. Some of these programs naturally fell short of expectations, and there are always detractors — ready to display their intellectual brilliance by speaking cynically of *all* types of human relations training. Real progress in supervisory methods has, therefore, been slow.

Supervisory personnel, continually aware of the intrinsic values of human relations, are the key to uninterrupted production, completion of projects successfully and on time, for they forge the links in the productive chain solidly together.

Your management is interested not only in the creative, bold steps you would take into unknown solutions to problems, but also in how quickly and productively (profitably) you can put these ideas into practical application. When the solution, or idea, leaves your desk and starts down the long line of being put into practice, the supervisors throughout that chain of action will determine to a great extent whether their individual components will function properly or whether a project will bog down under the weight of misunderstanding and apathy.

It is extremely important, therefore, to maintain good supervisory practices throughout the various departments through which the original concept must be translated. It means a thorough understanding of human relations yourself, and the ability to communicate this understanding and appreciation to the supervisory personnel under you. This can and probably must be done both by individual contact with your supervisors and/or by conducting actual courses of study on the subject.

FOOTNOTE: the foregoing paragraphs are a direct quotation from another of Western's "personal-professional development" series, Booklet E-7, titled "Supervision — for Professional Advancement" a copy of which is yours upon request, without obligation. Write to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. Box 1888, Tulsa, Okla. — **where supervision contributes greatly to the manufacture of heat exchangers of the highest quality, and where personal attention to detail is our watchword.**

in closed loop control or as advisory devices for operator guidance. Components are designed to meet typical process environments of high humidity, corrosive atmosphere and wide temperature extremes. They are housed in a special case with lock, ready for on-line installations. Basic components will also be sold to those who desire to assemble their own computers. *Electronic Associates, Inc.*
Circle number (51) on reply card

Rotameter Sizing Made Easy

Single-setting circular slide rule simplifies rotameter sizing calculations. It consists of two circular slide rules, one for solving liquid-service equations and the other gas and steam-service equations. Can be applied to any rotameter-type instrument. $1. *Brooks Instrument Co.*
Circle number (52) on reply card

Select Right Ball Valve

New brochure helps users to select the correct size and combination of metals, seals, seats and pipe ends of Econ-o-miser ball valves. Special features of the valve are illustrated. Five types of pipe ends — flanged, screw, socket weld, butt weld or weld-in-nipple — used with the valve are shown. Thirteen photographs, four line drawings and five charts give complete information and a cost comparison is included. *Worcester Valve Co., Inc.*
Circle number (53) on reply card

Automatic Analyzers

Automatic colorimetric analyzers monitor and control hardness in water supplies for chemical plants and refineries. They also are used for analyses of phosphate, residual chlorine, caustic, free acidity and fluoride. For example, they take a sample of a plant's water supply every 3 or 6 min and electronically analyze hardness present in such minute quantities as 0-3 ppm. *Milton Roy Co.*
Circle number (54) on reply card

Tapered Plug Valve

New Permaturn design uses a high lubricity plastic coating that reduces turning and provides lifetime maintenance-free operation. Valves handle services from jet fuels and chemicals to water and sewage. Another feature is a fixed adjustment assembly used on low pressure valves to maintain a constant tight seal and to ease turning. Extreme high pressure service valves have a threadless stem that reduces the high operating torques of conventional valves. *Rockwell Manufacturing Co.*
Circle number (55) on reply card

Tank, Vessel, Fabrication Aid

New 36-page, illustrated brochure gives behind-the-scenes picture of the wide scope of machinery, tools, materials, techniques and quality control procedures used in fabricating tanks, pressure vessels and other plate-fabricated equipment. Examples of a variety of product sizes, shapes and metals and some typical field-erected refinery columns and towers are illustrated. *Nooter Corp.*
Circle number (56) on reply card

Magnetic Tapes

High-density magnetic tape systems for use with Honeywell electronic computers will read or write data 40% faster than equipment now in commercial use. Some new systems in daily operation at Honeywell 800 installations are transferring data to and from magnetic tapes at a rate of 133,000 decimal digits per sec, compared with 96,000 for standard systems. High-density packing of data on tapes achieves greater speed and efficiency. *Minneapolis-Honeywell Regulator Co.*
Circle number (57) on reply card

Metering Pump Reagent Head

Newly developed metering pump reagent head assembly with stainless steel diaphragm can operate at temperatures up to 212 F. It eliminates need for remote head construction used strictly to obtain a diaphragm suitable for pumping aromatic and some highly halogenated products. *Lapp Insulator Co.*
Circle number (58) on reply card

Refractory Abrasion Test

An 8-page reprint describes results of an abrasion test for refractory brick and monoliths. Complete details as to techniques, equipment and results are described with text, photos, tabulations and charts. *Harbison-Walker Refractories Co.*
Circle number (59) on reply card

Electric Operator Announced

Now sold integrally with McCannaseal top-entry ball valves or separately for bolting directly to the bonnet of any already in service are electric operators for automatic and remote on-off flow control applications. Cycle time to fully open or close the valves is from 5 to 12 sec, depending on the valve size. The electrically-operated valves are

available in 1 to 8-in. sizes for pressures to 720 psig and temperatures to 1000 F depending on pressure and service conditions and may be serviced without removing from line. *Hills-McCanna Co.*

Circle number (60) on reply card

Paraffin Inhibitor

A complex organic formulation has been introduced to inhibit paraffin deposition and to disperse existing accumulations in lines and tank bottoms. A liquid—soluble in crudes, insoluble in water—it contains no chlorinated hydrocarbons, heavy metals or other ingredients known to be harmful to refinery processes and may be stored outdoors. *Hagan Chemicals & Controls Inc.*

Circle number (61) on reply card

Large Diam Fin Tube Detailed

Technical data is available on large diameter K-Fin tubing for use in convection sections of furnaces heating petrochemicals or hydrocarbons for processing; waste heat boilers; and for tank heating and other fired and unfired applications. These tubes are said to provide 10 times or more outside surface area per foot of length than plain bare pipe or tubing, increasing furnace's capacity and/or efficiency. *The Griscom-Russell Co.*

Circle number (62) on reply card

In-Line Flowmeter Test Kit

An in-line-test-kit for field testing GE industrial mass flowmeters without removing them from the line provides you with an immediate check when you want to test calibration and gives a set of calibration data that will be specific to your process fluid. With weights, lever, pulley, stopwatch cord and data record cards, it is simple to operate. *General Electric.*

Circle number (63) on reply card

Book On New Copolymer

Gantrez An, first in a series of new water-soluble copolymers, is the subject of a 40-page data bulletin. Applications are cited, and pointed out are some characteristics of this linear polymeric anhydride: solubility in water over the entire pH range; wide compatibility with water-soluble gums, resins, plasticizers and most metallic salts; effectiveness as thickener in aqueous or organic-solvent systems; stability in acid and alkaline solutions; dispersing, coupling, stabilizing and other protective-colloid functions; formation of highly polar films with specific affinity for a variety of surfaces; and insolubilization by polyfunctional compounds. *General Aniline & Film Corp.*

Circle number (64) on reply card

Distillation Column Controls

Eight-page bulletin outlining typical practices for control of distillation columns in the process industries. Typical instrumentation of the feed, bottoms product, reboiler circuit and overhead product phases of distillation is covered. Pertinent instrument loops are illustrated. *Fischer & Porter Co.*

Circle number (65) on reply card

Small, Fast Engines

New Model 50A series of diesel engines covers a range from 37 to 690 hp at 1800 rpm. These are four-cycle engines, both naturally aspirated and turbosupercharged, and offer compact efficient units in both the vertical in-line and V-type arrangements. Engines are particularly well adapted for electric power generation and for installations where long periods of uninterrupted running are required. Specifications are given in Bulletin 5000-A. *Fairbanks, Morse & Co.*

Circle number (66) on reply card

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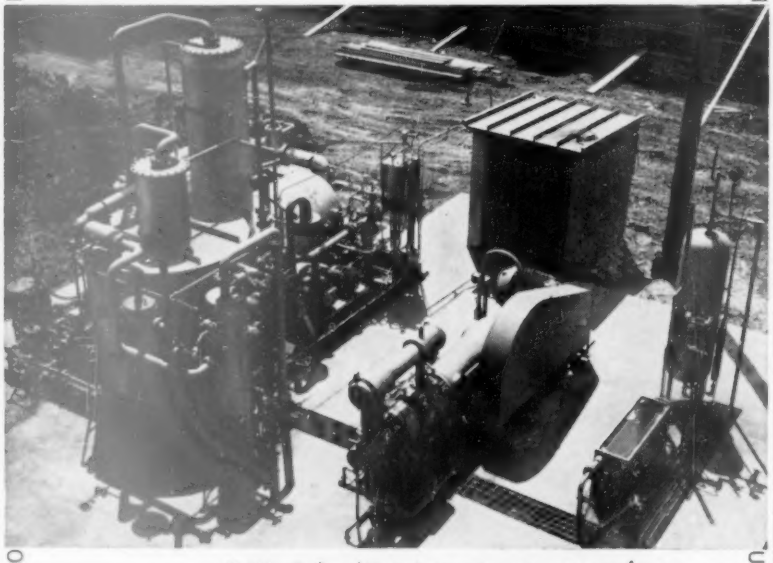
THE STANDARD LOOK: SELF-GENERATING GAS SYSTEMS

A few short years ago most of the gas used in the petroleum processing industry came in bottles trucked in from large gas generators. The big cost of the gas was in the handling.

EFFICIENT SMALL GENERATORS were perfected by Gas Atmospheres engineers. Labeled "Packaged Gas Systems", they made it profitable for even users of limited amounts of gas to operate their own systems.

HIGHEST PURITY GASES can now be produced with these smaller units, and complete storage, drying and purifying equipment is available.



10,000 cfh Gas Atmospheres nitrogen generator/compressor system in operation at the Baytown Refinery of Humble Oil & Refining Company.

PACKAGED GAS SYSTEMS are designed for volumes from 50 cfh to 50,000 cfh. Complete systems for the production of nitrogen, carbon dioxide, hydrogen, inert, reducing and annealing gases are better engineered by *Gas Atmospheres, Inc., 5353 West 161st Street, Cleveland 35, Ohio.*

gas Atmospheres, inc
equipment for producing industrial gases

PETROLEUM PROCESSING PETROLEUM PROCESSING PETROLEUM PROCESSING PETROLEUM PROCESSING

Horizontal Speed Reducers

Two completely new series of horizontal speed reducers — parallel shaft (type Y) with ratios 1.84-292:1 and right angle (type YB) with ratios 5.06-1207:1—are introduced in new bulletins. Capacity ranges from 9000 to 1,570,000 lb-in. torque in standard units (higher in custom units) with 22 standard sizes for each type, permitting precise and economical selection. Gears are single helical. Double ended shafts can be turned 180 deg for double gear life and have large diameters to accommodate maximum torque and overhung loads. *The Falk Corp.*

Circle number (67) on reply card

Antioxidant for Rubber

Announced is a new antioxidant that is highly versatile and can be used in a broad number of rubber applications. These include stabilization of synthetic rubber polymers of the stereospecific, SBR and butyl types, of oil-extended polymers, and of natural and SBR vulcanizates. It is non-toxic and relatively non-staining. "Ethyl" 702, a sterically hindered phenol of low volatility, consists of two of the basic molecules (2,6-di-*tert*-butylphenol) linked at the para position through a methylene (CH_2) bridge. *Ethyl Corp.*

Circle number (68) on reply card

Modernized Conduit Fittings

Lighter die-cast copper-free aluminum conduit fittings with: greater internal room for easier wiring; self-retaining cover screws for rapid assembly; long hubs for firm wrench grip; taper-tapped, full-cut threads for rigid joints; and integral bushing for easy pulling of conductors. Mark 9 Condulet conduit fittings are said to be ideal for use where corrosive solutions, substances or atmospheres are present. *Crouse-Hinds Co.*

Circle number (69) on reply card

Polybutene Uses Reviewed

Polybutene characteristics and present and potential uses of this versatile petrochemical product are reviewed comprehensively in a new 31-page technical brochure. Test tables and performance charts are included. *Oronite Div., California Chemical Co.*

Circle number (70) on reply card

Telemetering Described

Telemetering by time duration impulse signals is the subject of three 4-page specification data bul-

letins. With illustrations, functional diagrams, dimensions and typical installations, they explain the operation of Chronoflo telemetering elements. Wherever pressure, level or flow needs to be transmitted, recorded, indicated or totalized, Chronoflo components furnish systems that operate with equal facility over telephone or teletype lines, telegraph circuits, private signal lines, tone or microwave links. *B-I-F Industries.*
Circle number (71) on reply card

pH Analyzer System Described

Bulletin has been issued on the all-new system that includes: model "J" analyzer for pH employing a-c amplifier that provides stability of 0.01 pH/24 hr over -20 F to +122 F ambient temperature range; new glass and reference electrodes featuring short, compact bodies; and new electrode immersion and flow chambers for ease of installation and maintenance. *Beckman Scientific and Process Instruments Div.*
Circle number (72) on reply card

Easy-to-Install Coupling

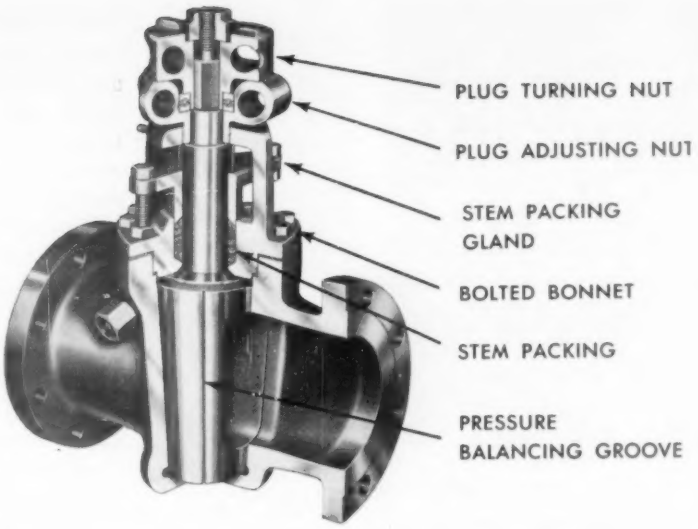
A coupling for metal and plastic pipe and tubing has been designed especially to minimize cost of systems requiring frequent disconnections and reassembly. Quikupl—in ½ through 6-in. sizes — provides straight-through, unrestricted flow. Only the gasket is in contact with the product flowing through the coupling. No reinforcement of ends is necessary, even with standard-gage tubing or Schedule 5, 10 and 40 pipe. *Cooper Alloy Corp.*
Circle number (73) on reply card

Steel Piping Data

Engineers, buyers and estimators will be interested in new data sheet TF-511, covering short radius, double extra strong 90-deg elbows and 180-deg returns in 1½ through 8-in. nominal pipe sizes. Charts show all pertinent elbow and return dimensions. *Babcock & Wilcox Co.*
Circle number (74) on reply card

Engine-Generator Series

New "J" line of industrial engines and engine-driven generators comprises a "family" of 12 basic engines featuring interchangeable parts; choice of gas, gasoline or diesel fueling; and water cooled or air cooled models. Included are 1, 2 and 4-cylinder models providing from 3 to 15 kw of electrical power. Engine horsepower range is from 7 to 40 for gasoline fueled models and 5 to 30 for diesel models. *Onan Div., Studebaker-Packard Corp.*
Circle number (75) on reply card



NON-STICKING . . . POSITIVE SHUT-OFF!

built-in features of

Hamer PLUG VALVES

Hamer non-lubricated, non-sticking plug valve with gland packed steam seal. Standard opening. Sizes 1" through 12" in ASA 150 lbs. and 300 lbs. series. Available in carbon steel and other metals to meet special corrosive and temperature conditions.

You don't have to depend on brute force or lubricant-lift to open or close a Hamer Valve. A special plug adjusting nut, acting as a screwjack, lifts the plug from its seat to assure easy opening and closing. This same nut adjusts the plug in its seat and secures it there for perfect shut-off. A vertical groove in the plug provides a pressure-balancing feature which further facilitates operation of the valve.

Being non-lubricated, there is no danger of product contamination . . . no lubrication expense. The gland packed stem allows packing to be changed under pressure while valve is on stream. Bar operated plug opens or closes with a quarter turn. Larger sizes are available with wheel operators.

Available in sizes, metals, pressures and temperatures to meet a wide range of services in refineries, chemical, petrochemical and other process industries. Ask your WECO, Chiksan or Hamer Valve specialist about the advantages of using Hamer Valves in your plant.

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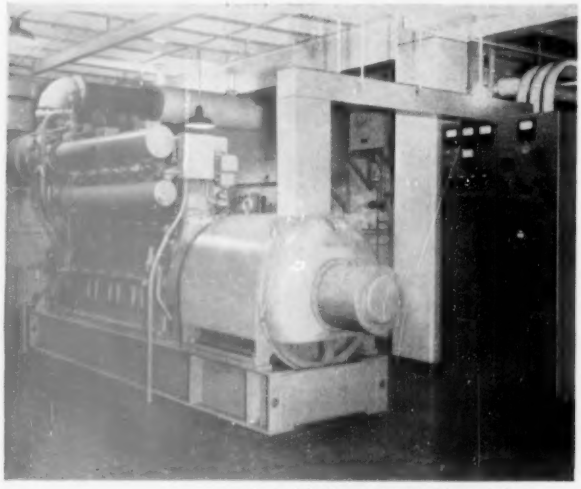


Typical high speed unit with control.

* IDEAL high-speed generators and control equipment pictured above are typical of installations in hundreds of America's leading industrial plants, public utilities and commercial buildings. Custom-designed for longer life with proven efficiency and economy, IDEAL equipment is backed by over a half-century of creative electrical engineering and careful, conscientious workmanship. Unified responsibility for generating units and controls assures you of *better* products *better built* for dependable service with lower operating and maintenance costs. Why not check with IDEAL on your next power application problem?

Write for bulletin 505

The IDEAL ELECTRIC AND MANUFACTURING COMPANY
613 East First Street Mansfield 5, Ohio
MOTORS, GENERATORS AND CONTROLS TO 10,000 H.P.

Gage Ring Assembly

New bezel assembly for some models of Acragage products consists of a polypropylene ring which snaps tightly into case front. It also can be furnished on aluminum and cast-iron cases. Lens is held in ring to prevent removal, but new lens can be easily installed in case of accidental breakage. Corrosion problems often encountered in petroleum refineries and chemical plant applications are believed to be eliminated. *Fulton-Sylphon Div., Robertshaw-Fulton Controls Co.*

Circle number (76) on reply card

Motor Applications

Descriptive information on gear-motors, adjustable speed drives and explosion-proof, non-ventilated, drip-proof and wound rotor motors highlight a 4-page application bulletin on motors and drives used in the hydrocarbon process industry. *Louis Allis Co.*

Circle number (77) on reply card

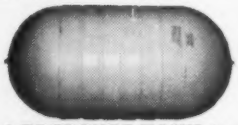
Cooler, Condenser Catalog

Specification data and dimensional drawings on horizontal core, air cooled heat exchangers for cooling and temperature control of oil, water and gases or for condensing vapors is supplied in 16-page revised Catalog 561. *Young Radiator Co.*

Circle number (78) on reply card

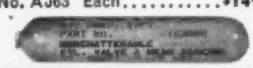
FLUID & GAS PRESSURE TANKS
STAINLESS & CARBON STEEL TANKS
(GOVERNMENT SURPLUS BARGAINS)

Steel tanks for the handling, storage and transportation of gases, beverages, fuels, hydraulic fluids and other liquids. Stainless steel tanks for corrosive acids and gases.



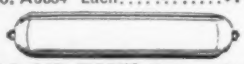
J-1 PRESSURE TANK Stainless steel, surplus aircraft oxygen tank. 48" long, 24" dia. Rated for 400 P.S.I. working pressure, 18,000 cu. in. vol., 77.9 gal. capacity. ¼" pipe thread fitting at each end. New condition. Shipping weight 247 lbs. F.O.B. Chicago.
No. AJ832.....$99.50

G-1 TANK Stainless steel. Capacity 2100 cu. in. (9 gals.) 450 P.S.I. ¼" pipe thread port at each end. 24" long, 12" dia. Shipping weight 19 lbs. F.O.B. Chicago. (Two for $27.00.)
No. AJ63 Each.....$14.95



NON-SHATTERABLE CO_2 CYLINDER This type of pressure bottle was used by the Armed Forces for inflating life rafts. 18¼" long, 3¾" dia. Has ⅛" pipe thread opening at one end. Capacity 2.98 lbs. of CO_2—at 1800 P.S.I. Shipping weight 10 lbs. F.O.B. Chicago.
No. AJ303.....$2.50

FREON TANK Capacity 22 oz. of Freon F22, 6 cc Methyl Alcohol. 18¼" long, 2" dia. ¾" pipe thread opening at one end. Equipped with brass valve. Shipping weight 3 lbs. F.O.B. Chicago. (Six for $8.00).
No. AJ834 Each.....$1.50



D-2 AIR TANK Carbon steel. Capacity 500 cu. in. (approx. 2 gals.) 450 P.S.I. ½" pipe thread port at each end. 24" long, 6" dia. Postpaid. (Two for $8.50).
No. AJ391 Each.....$4.95

CORNELIUS HIGH PRESSURE (1500-2000 P.S.I.) AIR COMPRESSOR Three cylinder, 3-stage compressor, complete with 27 volt, D.C. 20 amp. motor, with fan. Rated 1500 P.S.I. continuous duty, 2000 P.S.I. intermittent. Pressure switch in base. As released by Air Force, in used, serviceable condition. Covered by our 30 day GUARANTEE. 11½" long, 7" high, 9" wide. Shipping weight 12 lbs. F.O.B. Chicago. Limited quantity.
No. AJ549.....$35.00

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Anti-Foaming Agent

New foaming agent contains no silicones, does not separate and is almost water-white. Company claims that Ex-Foam 333 is twice as effective as other anti-foaming agents now on the market. Product has low specific gravity and high bulking value. *Troy Chemical Co.*
Circle number (79) on reply card

Dump Packing Described

"Maspac Plastic Tower Packings" is a technical bulletin on specially designed thermoplastic dump-type packings for gas-liquid contact systems. Because of low specific gravity of the new product line, Dow believes cost savings can be realized through design of thinner wall towers. *Saran Lined Pipe Co.*
Circle number (80) on reply card

High Pressure Flowmeter

A new 2-in. model of the Whirl-Flo flowmeter provides economical and accurate means of measuring gas or liquid flow. Pressure rating of the rugged unit with an all-cast body is 5000 psig. It is especially suited for high pressure petrochemical processes. *Rotron Controls, Div. of Rotron Manufacturing Co. Inc.*
Circle number (81) on reply card

1600 F Hot Helium Valve

Designed to operate at temperatures up to 1600 F, the hot helium line of valves offers the petrochemical and processing industries full advantage of elevated temperature process control. Valves are available either in solid body angle or globe pattern and in all ASA ratings and sizes as well as a wide range of standard and special body connections. Features include all-welded construction, bellow seals, auxiliary stuffing box and vent connection. Sphere or knife edge seating assures minimum leakage. *Security Valve Co.*
Circle number (82) on reply card

Boiler Pressure Controller

Master pressure controller for multiple boiler installations is capable of maintaining steam pressure within ±2% over operating ranges from 15 to 2000 psi. It uses a K Monel bourdon tube as the primary sensing element. Operating in conjunction with electronic balanced bridge control circuits, controller may contain up to nine master sending potentiometers, enabling it to control nine boilers from a common header. Same controller, with a filled

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PIPE JOINT CLAMP STOPS LEAKS
at joint where pipe is screwed into fitting

SKINNER-SEAL
PIPE JOINT CLAMP stops leaks at joints where pipe is screwed into fitting. Any temperature—any pressure up to 2,000 pounds. Saves the cost of tearing out and renewing leaky fittings. Prevents shutdowns. In stock at most oil supply stores.

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EMERGENCY PIPE CLAMPS for safe, sure, lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12," for steel and C.I. pipe. Stocked by practically all oil supply stores.

Complete line of Repair Clamps. Send for Catalog 54!

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

bourdon tube system primary, may be used as a temperature controller over ranges from 200 to 1000 F. *Reliance Instrument Div., Electro-Mech Corp.*
Circle number (83) on reply card

Explosion Venting Window

Now appearing in explosion-risk plants is a new window assembly designed to ameliorate the effects of an internal blast. The explosion venting window is fitted with shatterproof 14-in. by 20-in. Kemlite Glasbord polyester panes, bowed outward into a slight parabola and pre-loaded into a rubber stop to form a tension seal equalling minimum "blowing" pressures. If an explosion occurs, the panels push out but don't fall from the rubber frame to permit release of gas build-up. Following an internal blast, equalizing external pressures reset them. Patents for the explosion vent window are held jointly by Parke-Davis & Co. and Bond International Inc. *Kemlite Corp.*
Circle number (84) on reply card

Storage Tank Bulletin

New 6-page bulletin lists uses and graphically describes advantages of Glasteel Chemstor tanks for storing many products including materials that are corrosive, purity-sensitive and sticky. It details such design improvements as increasing the operating temperature range from 125 F to 180 F for sizes up to 10,000 gal. Tanks with agitators or heating panels, or both, are also discussed. *The Pfaudler Co.*
Circle number (85) on reply card

Moisture Analyzer

New electrolytic analyzer measures moisture in a system at high pressure with minimum expansion. Complete instrument includes all necessary components for accurate measurements. Lightweight sample module is explosion-proof and includes thermostatting for maximum stability. Gas input pressures up to 10,000 psig are handled. *Manufacturers Engineering & Equipment Corp.*
Circle number (86) on reply card

"Push-On" Hose Fittings

New line of hose fittings and assemblies insert or push on with barbed stems that lock the fitting in the hose. There is no need for external clamps or ferrules with these fittings, designed for conveyance of air, water, oil and petroleum base fluids at pressures to 250 psi. Available in SAE 45-deg swivel, JIC 37-deg swivel and male pipe thread end models, they are made in a wide range of sizes for hose ID of ¼ to ¾ in. *Lenz Co.*
Circle number (87) on reply card

Portable Electronic Counter

New portable solid-state electronic counter operates either from conventional 115-v a-c power or from a 12-v vehicular storage battery. Designed for rugged field service, the counter weighs only 16 lb and is housed in a Halliburton aluminum case, 13 in. by 18 in. by 6 in. Controls have been simplified and connectors are clearly labeled and keyed to make hook-up errors impossible. Circuit improvements enhance its operation with provers and pulsers. *Datalox Div., The W. W. Henry Co.*
Circle number (88) on reply card

Vibrating Screen

New unit is designed for lighter-duty screening requirements in chemicals, minerals and other products for sizing, scalping and dewatering applications. Features include a unitized vibrator cartridge, easy amplitude adjustment and 98% vibration isolation. Descriptive literature is available. *Overstrom & Sons Inc.*
Circle number (89) on reply card

Automation Equipment

Telemetering, supervisory control and data logging systems are among custom-made monitoring and control systems covered in new bulletin, No. 301, available from Dynel, Inc., electro-mechanical division of Varec, Inc. *Dynel, Inc.*
Circle number (90) on reply card

Insulated Thermocouple Wire

Information on Serv-Rite insulated thermocouple wire, thermocouple extension wire and multipair extension cable is contained in a new 12-page catalog. Insulation information and sizes on over 150 standard items that meet most common industrial requirements are given. *Claud S. Gordon Co.*
Circle number (91) on reply card

Master Control Stations

Descriptive literature is available on two new hazardous area pushbutton stations that feature all controls located in one location to offer design potentials never before obtained with separately mounted units. These master stations, with space to accommodate 85 control units, meet both NEMA 7 and 9 specifications, respectively, and are intended for use where explosive gases or combustible dust is prevalent and where flame propogation must be arrested. *Gemco Electric Co.*
Circle number (92) on reply card

Membrane Filter Discussed

Advantages and applications of the Polypore membrane filter are discussed in a 24-page catalog. Recommended filtration accessories, filter characteristics comparison table, filter compatibility table, as well as complete price lists for all types of Polypore filters, are included. *Gelman Instrument Co.*
Circle number (93) on reply card

ARKANSAS LOCATION

3 — Worthington 3500 CFM air compressors, 24 x 15, Model #LTC-4, 500 HP gas engine drive.
1 — Chicago-Pneumatic 3060 CFM air comp., 60 PSI, #19-32-30-18x24, steam driven.
20 — 28,000 gal. horiz. steel tanks, 11' x 38' ASME 75 PSI WP.
20 — Large steel API heat exchangers.

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Hold your next get-together in New Orleans!

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1100 guest rooms, 10 handsome meeting rooms. Tulane Room seats 1550 for meetings, 1000 for banquets. Charcoal Room. Contact Sales Dept.

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In any engineering or construction project the real basis of economy is fast completion. Brown & Root has become legend for putting plants "on the line" ahead of schedule. This is possible because, with its own personnel and equipment, Brown & Root has the capability of a "turnkey" job. Every step is carefully controlled, from engineering through the manifold steps of construction and equipment installation. This "control" can be interpreted in fast, economical completion for you. If your organization is planning new construction or plant expansion, you'll profit by talking to the man from Brown & Root.

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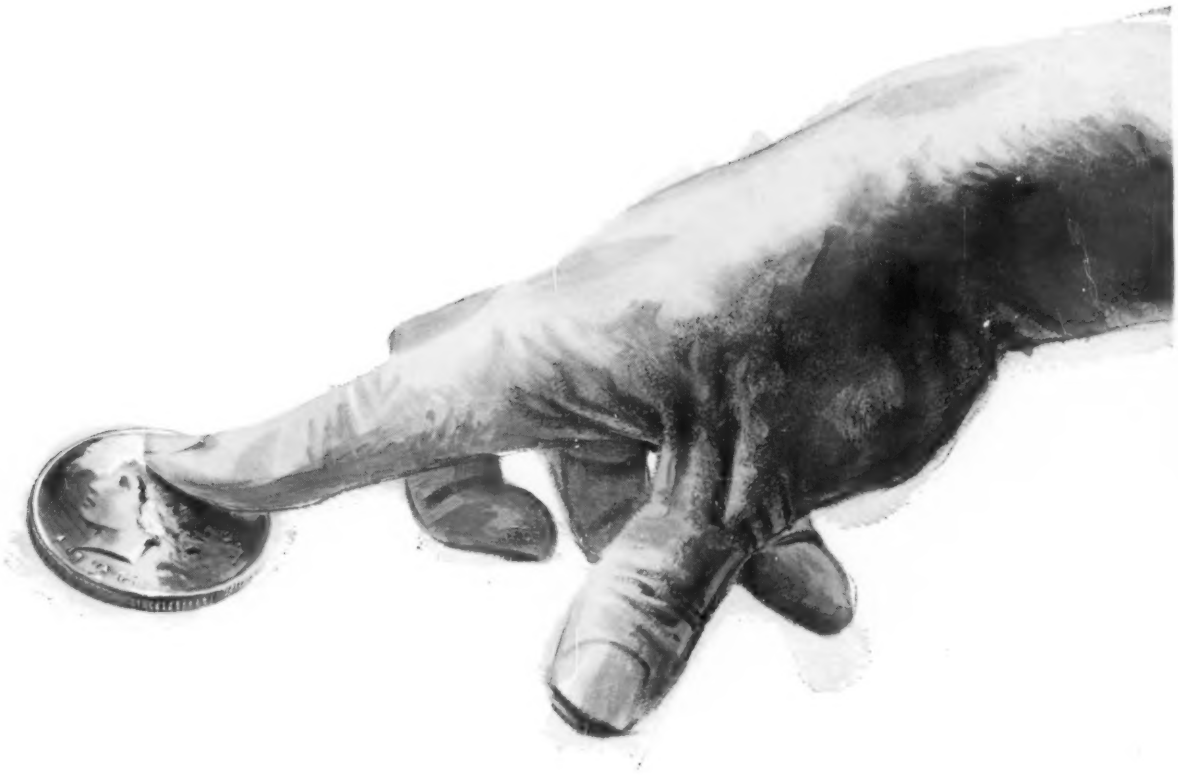

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POST OFFICE BOX 3, HOUSTON 1, TEXAS CABLE ADDRESS: BROWNBILT

New Barber-Greene 7′ Wheel Ditcher crowds through rugged caliche in Texas—at speeds many times greater than ladder ditchers or back hoes working in the area. Write for details.

NEW 7-FOOT WHEEL DITCHER

digs more ditch . . . deeper ditch than any machine in its size range

Barber-Greene's new 7′ wheel ditcher offers more ditch for the money than ever before. It digs deeper than any wheel ditcher in its size and price range.

Check these advantages:

Advanced design. Greater maneuverability—smaller, more compact than other wheel ditchers digging to 7′. The only wheel ditcher available with point of balance at center of tracks.

Costs less to operate—exclusive Barber-Greene design advantages add up to more ditch per day with less maintenance . . . less down time . . . less wear.

Full range of crowding speeds—exclusive Barber-Greene Hydra-Crowd provides infinite range of crowding speeds . . . permits top digging capacity in all conditions.

Easier to operate—full hydraulic controls within easy reach means less operator fatigue . . . easiest steering . . . greater accuracy.

All-hydraulic spoil conveyor—10′ variable-speed conveyor loads directly into trucks . . . handles spoil at speeds to 640 fpm. Folds to 8′. Rubber impact rollers reduce belt wear, eliminate material build-up beneath belt.

New, compact size—only 26′5″ long, 8′6″ high in operating position. 7′ wide across tracks.

Manufacturer of the only modern ditcher line

Representatives in Principal Cities of the World

Barber-Greene BG

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Other Plants: DeKalb, Milwaukee, Detroit, Canada, England, Brazil, Australia

CONVEYORS • LOADERS • DITCHERS • ASPHALT PAVING EQUIPMENT

Shaping the Future

BACTERIA IN TANKS

Accumulation of bacteria in oil storage tanks, which can affect the quality of certain fuels, is being studied by the Midwest Research Institute in Kansas City, Missouri. Institute chemists and bacteriologists have conducted an extensive inquiry into growth of fungi and yeasts, as well as bacteria, in kerosine, diesel fuel, jet fuel and fuel oils. Ordinarily, gasoline is not significantly affected by an infiltration of these small organisms, but kerosine and jet fuels seem to be unusually susceptible, it has been found. Futhermore, organisms can spread from one tank, or fuel system, to another in course of transportation. Laboratory work is continuing, with the aim of determining measures to prevent damage or deterioration of fuels.

HELIUM CONSERVATION

More than 4 billion cu ft of helium is being wasted annually, depleting our resources at a rate ten times greater than present consumption. This was the statement of James K. Carr, Under Secretary of the Department of Interior, speaking before a meeting of the Independent Natural Gas Association. He pointed to the future great need of helium and urged more gas men to apply for contracts for helium extraction, for which Congress has allotted $47,000,000.

GAS ANALYSIS

Helpful to the gas transmission industry will be the method for full-range chromatographic analysis of natural gases published by the Natural Gas Processors Association, formerly Natural Gasoline Association of America. Thus, for the first time, a reproducible procedure is made available for use of this relatively new analytical tool. It is the result of a cooperative effort by 30 oil company and commercial laboratories under NGPA supervision.

PERMIT CONTESTED

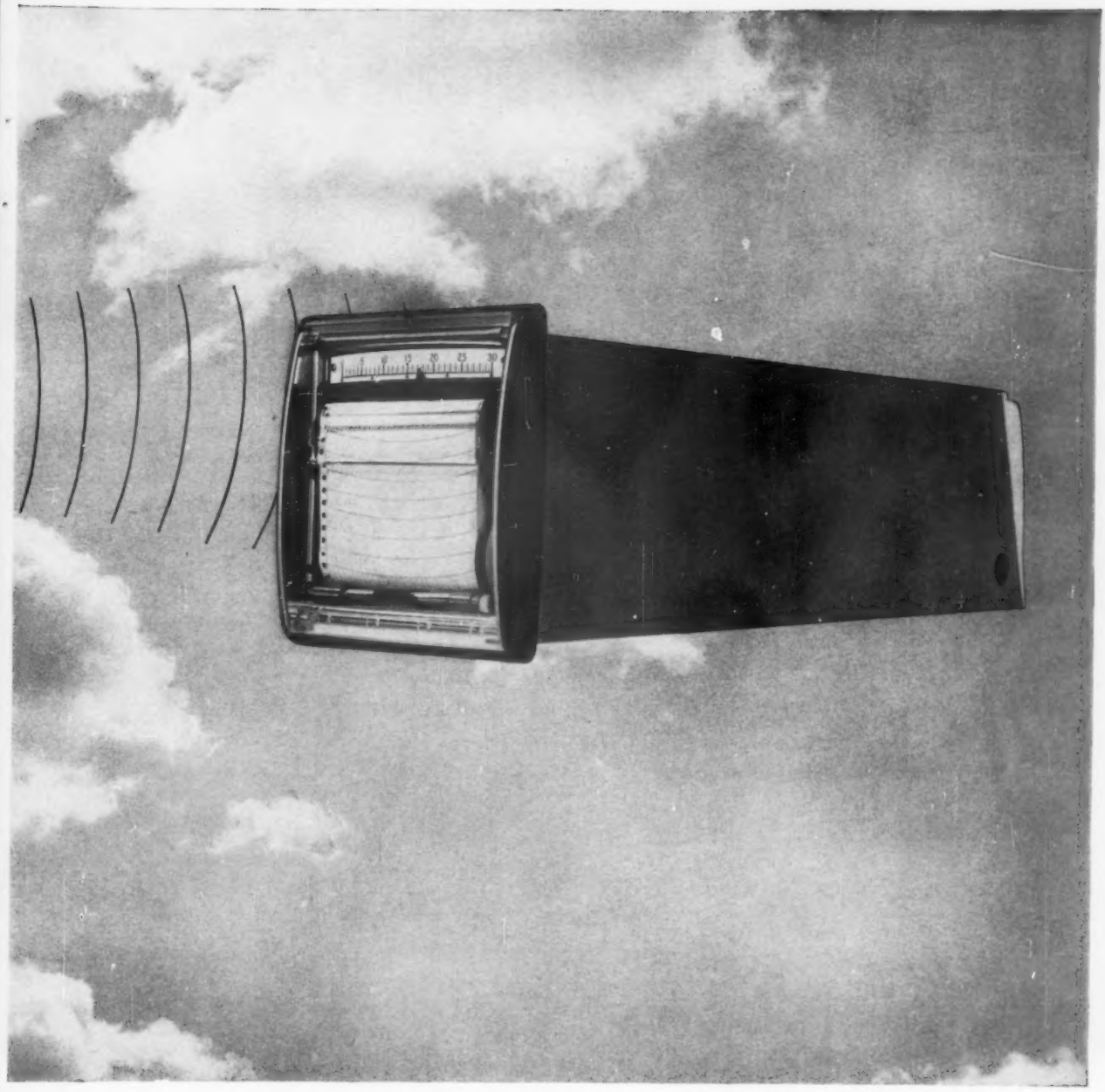
A permit granted to Matador Pipe Line Co. to build a crude oil line in Manitoba has become a case of great significance as a constitutional issue. The line would move North Dakota crude to the Interprovincial line at Cromer then into the St. Paul area. Two railroads have appealed the permit issued by the National Energy Board on a point of law. NEB has interpreted the phrase "public convenience and necessity" as meaning desirable from the standpoint of public interest and not "essential or indispensable." Intervenors maintain the board must adhere to the literal terms of the Energy Act and not make assumptions.

new, 2-second cycle, all-electronic eliminates mercury switches . . .

A giant step forward in the science of telemetering measured variables — this is Foxboro's new telemetering system.

Completely electronic, the system abandons earlier mechanical means of producing a pulse-duration signal. Dry reed switches replace troublesome mercury switches . . . a photo-diode switch replaces the mechanical cam switch. There are no synchronization problems . . . no vacuum tubes . . . no periodic maintenance.

Standard impulse-duration cycle on the new Foxboro telemetering system is 2 seconds — 4 times as fast as any other standard system. The signal can be carried over any



telemetering system makes maintenance "plug-in simple"

transmission medium. Modular construction makes servicing easy as "plugging-in" a new component.

This is the telemetering system all industry has been asking for. For full details, write for Bulletin 17-12. Or better yet, ask your Foxboro Field Engineer for the complete story. The Foxboro Company, 3812 Norfolk Street, Foxboro, Mass.

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For Further Information on Advertised Products See Reader Service Card

CONTRACTOR "SIZES UP" NEW TD-15 AT FACTORY ...FIELD PERFORMANCE CONFIRMS JUDGMENT

Digging a pit with the new TD-15, operator Jim Hoyt uses fast Shuttle-Bar control for instant reversing to speed the cycle. The "15" is the only crawler in its power class with the shock-load prevention of ball-joint suspension—basic in International's 3-point track mounting design.

Seeing what goes into the TD-15 at International's famous Tractor Works convinced oilfield contractor, George Baize he'd get more out of this machine—in performance, long life, low upkeep. His 62-inch-gauge Oilfield Special TD-15 is equipped with the 8-foot outside push-arm hydraulic bulldozer. Big in work capacity, this rig is sized for easy highway haulage without special permits.

Oilfield Contractor George Baize, Hill City, Kansas, visited International's "Tractor Works" in Chicago—to size up new TD-15 advantages, first hand.

Mr. Baize noted the big tapered roller bearings that go into the new "15's" transmission; the transmission oil pump that circulates and filters lubricant for extra long gear life. He observed economy and long life features like the new sintered metal steering clutch discs with built-in heat-defiance; new dry-type air cleaner with transparent, quick-dump collector.

He examined advances that increase TD-15 undercarriage strength and life: new drum-type front idlers to team with famous, precision welded double-box beam track frames. New self-cleaning, power-saving strutless track links. Improved, high-

efficiency full-floating seals to protect the long life Dura Rollers—the track rollers you grease only once per hundred 10-hr. shifts!

Goes home and buys one!

And when Mr. Baize returned to Hill City, he bought a new International TD-15. He's putting his new TD-15 on the hardest jobs he can scare up—reports getting the perfect performance he needs to make money on them! And his operator Jim Hoyt says: "We try to cut our location work and pit-digging time with all our dozers—still I can beat our best (previous) time with this new International TD-15, because of its digging ability, power, and speed."

Prove TD-15 ability to top its power class in production, operating economy, and on-the-job dependability for toughest oilfield work. Try the new "15" equipped with outside push-arm hydraulic dozer—for digging pits, clearing sites, doing all kinds of location jobs. Let your International Construction Equipment Distributor demonstrate.

International® *Construction Equipment*

International Harvester Co.,
180 North Michigan Ave., Chicago 1, Illinois
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DE LAVAL

IMO® pump

saves more than...

80% of weight
70% of space
50% of installed cost

...in crude-oil pumping

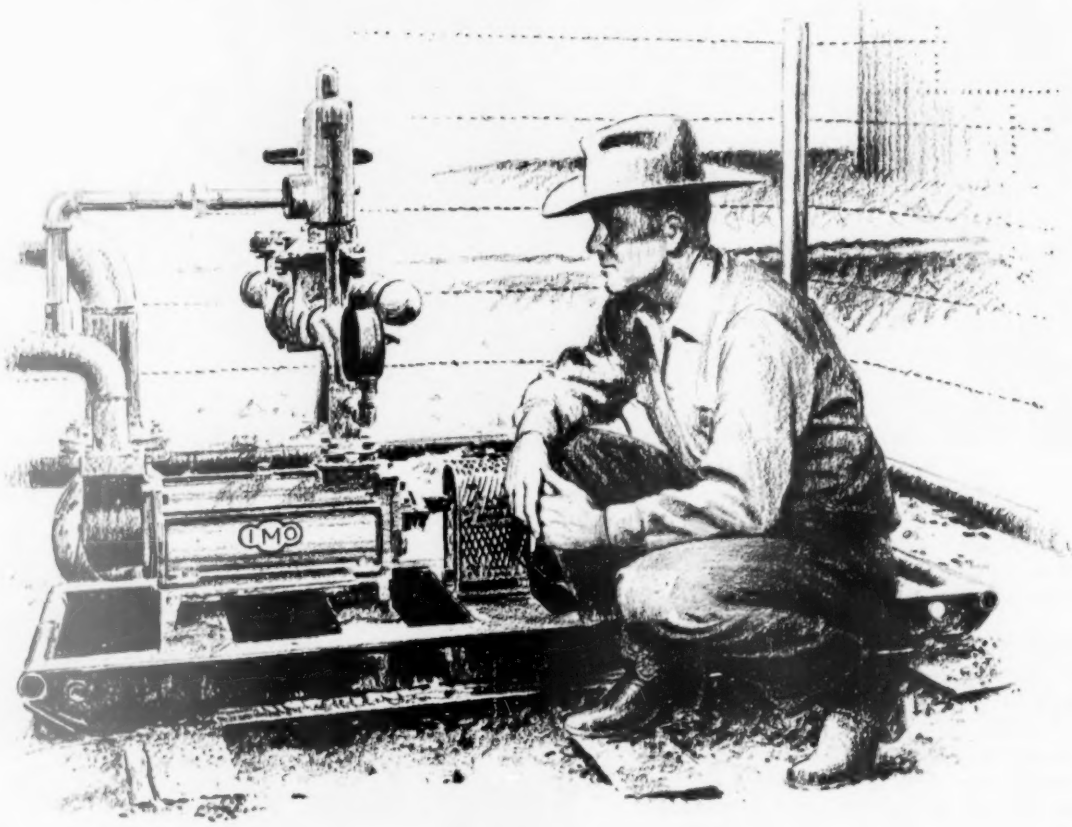
These savings — based on comparison of an IMO pump with a typical reciprocating pump of equal capacity — are among the benefits the IMO pump offers you for crude-oil pumping.

In addition . . .

- The smooth, non-pulsating flow of the IMO pump eliminates the need for the surge suppressors required with reciprocating pumps.
- The IMO pump runs at standard motor speeds. It can be connected direct to a motor without belts, sleeves or reduction gears.
- The IMO pump has a capacity of over 3,000 gpm.
- Maintenance is low . . . the IMO pump has only three moving parts.

In thousands of applications, pumping crude oil and other petroleum products, the De Laval IMO pump is giving outstanding service. It can bring the same advantages to your installation. For application and performance data, selection information, dimension drawings and tables, write for Bulletin IM-3200.

De Laval Steam Turbine Company, Trenton 2, N. J.



IM-DL-104

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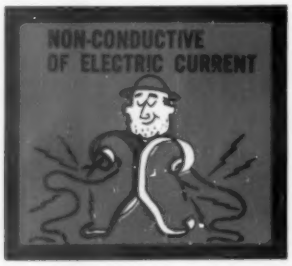
MARINE PROPULSION AND AUXILIARY EQUIPMENT • HELICAL AND EPICYCLIC GEARS • TURBOCHARGERS

PLICOFLEX LAMINATED

Pipe Protective Tape

Plicoflex butyl-vinyl laminated pipe protective tape guards your pipe under all conditions. Plicoflex tape is



The liquid butyl Plicoflex primer and flexible butyl underlayer fill in all pipe surface irregularities for positive coverage.

The vinyl outer layer increases resistance to

Try Plicoflex on your next pipe protective job, you'll find it goes on easily, that total costs are low and that it gives the best protection available to your pipe.

10 colors, 4 thicknesses available.

Write for descriptive literature or demonstration.

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FOR THE UPS AND DOWNS OF DIFFICULT TERRAIN

J&L Electricweld Line Pipe. Mountainous country gives you a good indication of the quality of line pipe. It places a premium on the ability of pipe to bend to contour. And keeps you keenly aware of such factors as weldability and roundness.

Real line pipe quality begins with the steel itself. That's why J&L offers you such certainty. As a major steel producer, J&L controls line pipe quality from iron ore to finished product. Every length of J&L Line Pipe is produced on one of the most modern mills in the world. Welds are ultra-sonically tested and are sound from end to end. And you get pipe that is uniformly round and easy to weld on the job. J&L Line Pipe is available from 6⅝ inches through 12¾ inches.

Jones & Laughlin Steel Corporation

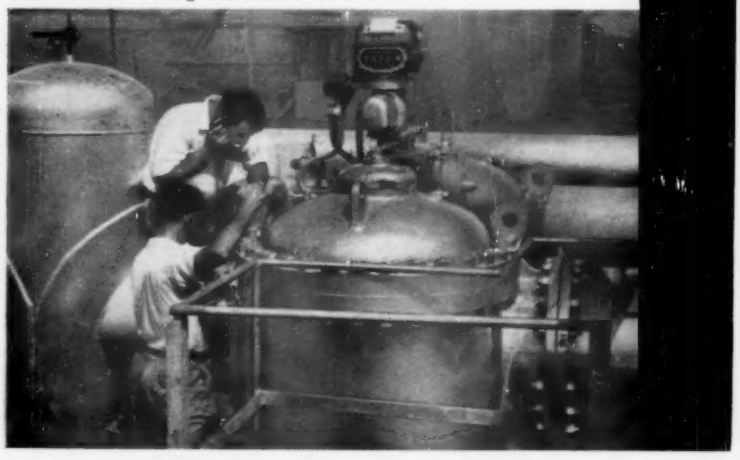
3 Gateway Center, Pittsburgh 30, Pennsylvania

J&L STEEL

Giant
A. O. Smith
W-1750
Meter

RECORDS

Measuring the wealth of an oil oasis . . . This new W-1750 meter is used to accommodate the 24-inch pipeline which transfers crude from the desert terminal to tankers at loading docks. The W-1750 will meter crude at a rate of 25,000 barrels per hour — accurately and dependably. A. O. Smith's factory representative was on hand during this installation.



25000 BARRELS PER HOUR!

Unique A. O. Smith meter installation in Middle East sets "world record" for positive displacement capacity

Even in this age of technological miracles, the precise measurement of 25,000 barrels of crude every hour *through one meter* staggers the imagination. Yet, when the problem was presented to A. O. Smith engineers, it didn't stagger theirs very long.

A. O. Smith already had a great store of experience in large capacity metering with the world's largest rotary positive displacement meter — B-875. By designing a special manifold to join two B-875's and combining the readings on one counter, the job was done.

B-875 meters have also been supplied for multiple meter installations in the Middle East to handle capacities of 125,000 barrels per hour.

The durability of the B-875 meter is as renowned as its accuracy. When one of the meters recorded 100,000,000 barrels of crude and refined products it was thoroughly examined. No replacement parts were required to return the meter to service.

The new Armorloy solid film lubricant process is also responsible for the exceptionally high metering capacity of A. O. Smith meters.

These huge A. O. Smith meters are going places . . . The highly successful performance of the world's largest rotary positive displacement meter has earned it many important assignments around the world. This A. O. Smith shipment was destined for Libya. No matter where you go, A. O. Smith meters are world-famous for their accuracy, dependability, rugged performance.

Through research ...a better way

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For Further Information on Advertised Products See Reader Service Card

Looking for a solution to your

BRPE Tape Punch

Perforates 5, 6, 7 or 8 level tape at 100 char/sec. Synchronous unit, with parallel-wire input. For business machine readout, or, with deserializer, for data reception over DATA-PHONE or other high speed communication channels.

CX Tape Reader

Reads fully perforated or chadless tape—5, 6, 7 or 8 level codes—at 100 char/sec. For use as computer input device, or, with serializer, for transmission over DATA-PHONE or other high speed communication channels.

LARP Tape Punch

Produces 5, 6, 7 or 8 level tape at 20 char/sec. Parallel input. May be used for cross-office relaying, data collection, or providing by-product tapes from business machines. Companion input tape reader available (LX).

data communication problems?

LBXD Tape Reader

Dual-purpose model: permits, (1) tape transmission on-line and/or to business machines, or (2) direct read-out (without tape) from business machines for on-line transmission. Speed, 10 char/sec; 5, 6, 7 or 8 level codes.

LPR Typing Tape Punch

Produces 5-level "common language tape," prints data right on tape for handling ease. Speed, 10 char/sec. Non-typing version of this unit also available (LRPE).

LXD Tape Reader

For on-line transmission of 5, 6, 7 or 8 level tape at 10 char/sec. Transmission may be pulsed.

Teletype Corporation offers an extensive line of paper tape punching and reading equipment, with capabilities for meeting a wide variety of needs. In addition to the individual units illustrated, numerous combination sets are available—such as gang-mounted punches and readers, punch-reader relay sets, high-low and low-high speed converters, and page-tape consoles.

Applications range from high or low speed on-line transmission to centralized data collection . . . data distribution . . . data input/output for business machines . . . by-product tapes . . . and many others.

With Teletype-built tape units, you can solve your problems with precision-engineered equipment, backed by over fifty years of continuous design and manufacturing skill in the data communications field.

Teletype equipment is manufactured for the Bell System and others who require the utmost reliability and versatility from their data communications systems. For further information, write to Teletype Corporation, Dept. 47M, 5555 Touhy Avenue, Skokie, Illinois.

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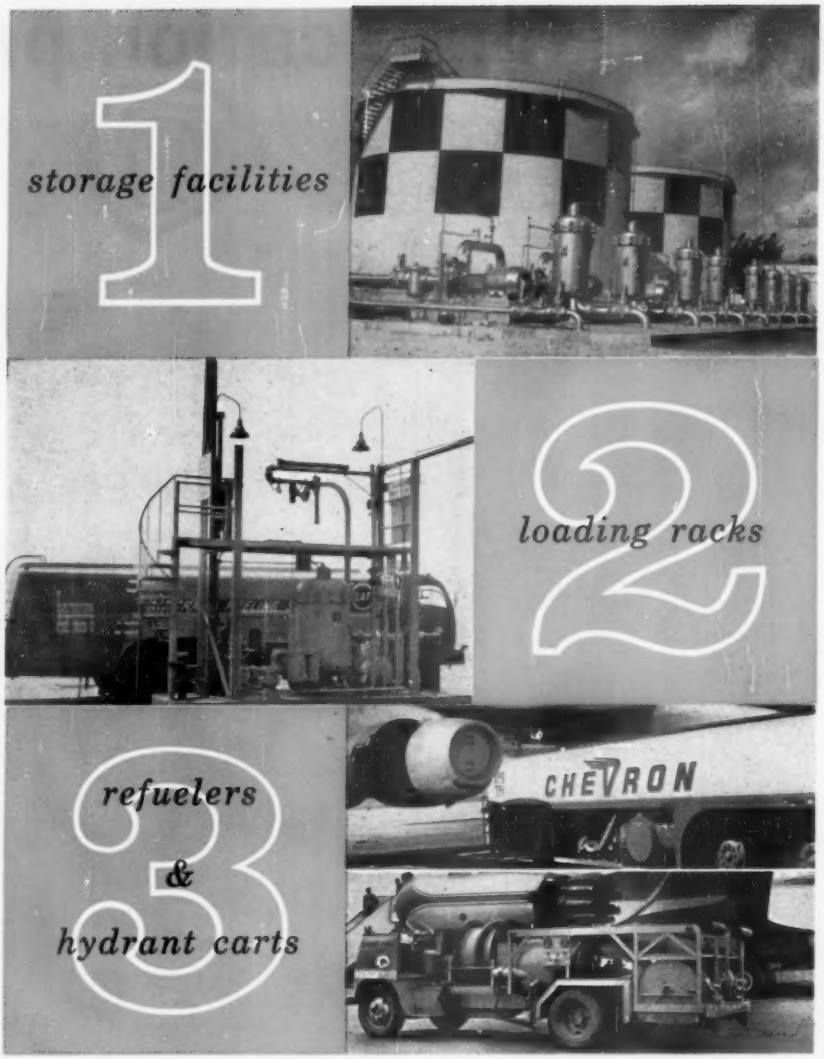

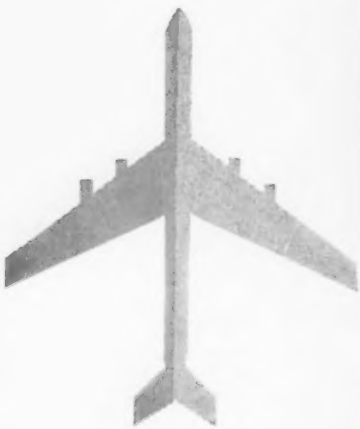

Warner Lewis Separator / Filters

Your Silent Servant of Safety

CHECK JET FUEL 3 TIMES FOR SAFETY

Jet fuel picks up dirt, water, rust, scale and other contaminants in pipelines, storage tanks and feeder piping. To reduce jet engine maintenance and costly down time due to contaminated fuel, Warner Lewis 2-stage Separator/Filters REMOVE essentially all solid contaminant as well as 100% free or entrained water. Warner Lewis Separator/Filters are designed to customer specifications for the 3 basic fuel handling points serving airports: 1) storage facilities, 2) loading racks 3) refuelers and hydrant carts. Safety is of major importance to your company. Save hours of costly maintenance and protect your jets by fueling through Warner Lewis 2-stage water Separators/Filters.

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PERFORMANCE AND ACCEPTANCE

Repeat orders roll in for Cameron Ball Valves. Enthusiastic reports from test installations during the past three years show performance justifying every claim.

The reasons for this enthusiastic acceptance are plain – simplicity, with a minimum of parts – no bonnets or glands to leak – no lubrication for bearings or seal – easy to operate with Teflon bearings – tight shut-off indefinitely, with rotating seats – sealed for life, no maintenance.

Plan now to profit from the trouble-free operation and lack of maintenance expense of Cameron Ball Valves.

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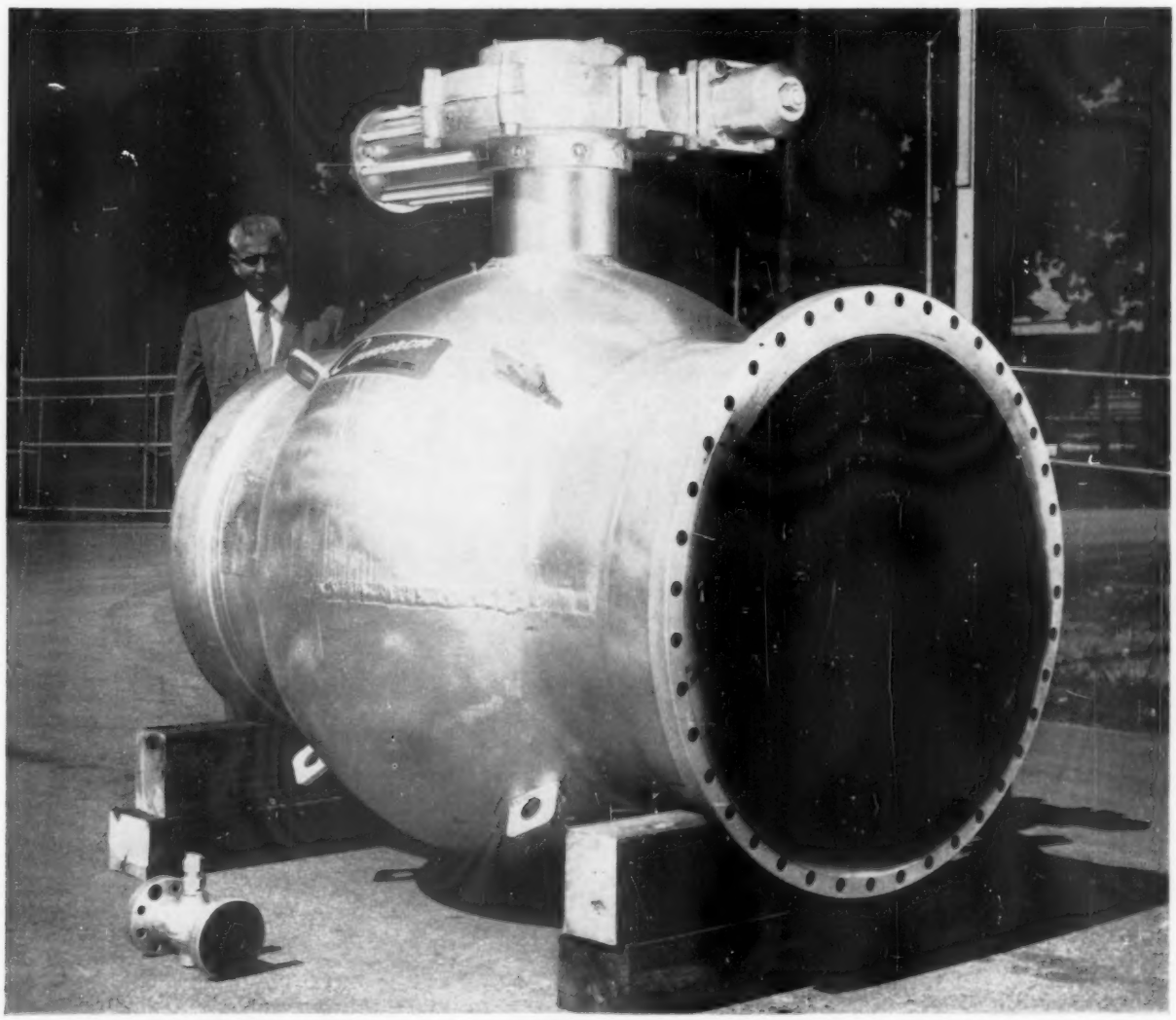

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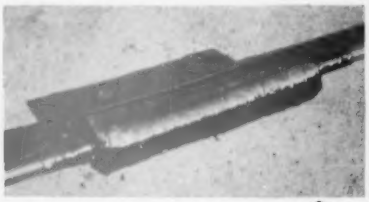
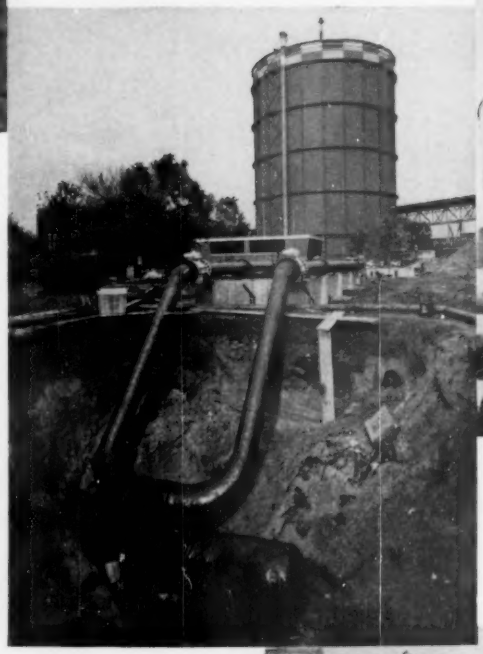
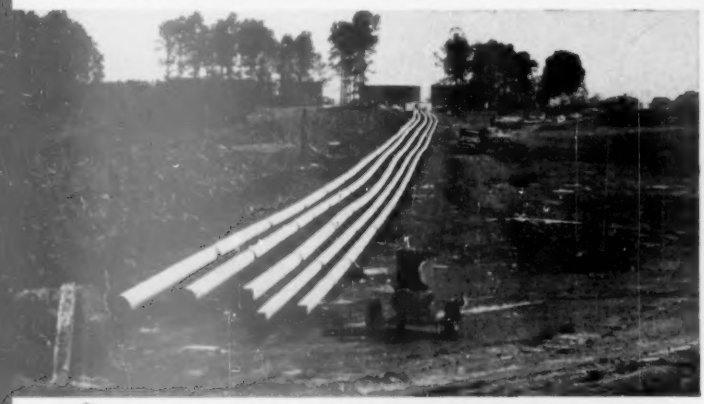


CABLE AND CABLE SPLICES in communications service are effectively and economically protected by TAPECOAT.



Lines in **OFF-SHORE DRILLING** operations need joint protection equivalent to the mill-wrapping on the pipe. TAPECOAT is most economical because it gives lasting protection in underwater service.



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Lines buried in cinders in **RAILROAD YARDS** need the sure protection provided by TAPECOAT. There's a size for every purpose from 2" to 24" in width.

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GAS

comes to Grandyle Village ...through Bethlehem line pipe

Into the ground it goes! Much of the Bethlehem pipe used on this project was plastic-coated with X-TRU-COAT by Pipeline Service Company, Sparrows Point, Md.

Iroquois Gas Corporation began laying distribution lines early in 1961 in Grandyle Village, a promising new suburb on Grand Island in New York State's Niagara Frontier. Connected to a 12-in. line laid under the river last Fall, these lines will bring gas to an initial 400 customers by the end of the year. The company estimates that, at the end of the 3-year, first-phase of the project, more than 80 per cent of the island's consumers will be hooked up to their lines. Some 170,000 ft of 2- to 6-in. line pipe will be involved, the great majority of it coming from Bethlehem's continuous buttweld and electric resistance-weld mills at Sparrows Point, Md.

Bethlehem Line Pipe All the Way

Thousands of tons of Bethlehem large-OD, electric fusion-weld line pipe are used in the transmission lines which will bring natural gas all the way from the Southwest. Smaller-OD Bethlehem steel pipe will carry it into the individual homes. Wherever it's used, Bethlehem line pipe provides tops in service . . . all the way.

Grand Island Is Booming

Just south of the Falls, the Niagara River divides to flow around an island larger than Manhattan. Virtually undeveloped until 1935 when two new bridges provided access to the mainland, Grand Island is one of the most promising growth areas on the Niagara frontier. Home and industrial construction is booming, stimulated by far-reaching plans to bring community services—such as natural gas service—to within reach of every corner of the island.

Steel *for Strength . . . Economy . . . Versatility*

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BETHLEHEM STEEL

BETHLEHEM STEEL

by Leslie O. Rowland

Weather No Deterrent Canada Has Historical Year

Credit Canada with a rewarding, history-making year of pipeline construction. She has accomplished one of the largest construction jobs in her pipelining history to help send Alberta gas to California, has put British Columbia on pipeline maps in a big way and has found practical ways of carrying on almost all phases of construction during the entire year.

Main gas transmission mileage constructed this year is approximately 1000 miles. Although short of the 2000-mile record-figure set during the previous peak period of construction of the systems of Trans-Canada Pipe Lines Ltd., Westcoast Transmission Co. Ltd. and Inland Natural Gas Co. Ltd., it nevertheless is a substantial volume in contrast to the expected low level of gas line construction in 1962.

This is the gas line construction outlook when the big current export projects have been completed: a few additional laterals in Alberta; possibly one new border-crossing main line between a new gas field in northwestern Alberta and the Westcoast system in northeastern British Columbia; a small addition to Saskatchewan Power Corp.'s grid; and some additional utility company main line construction in Alberta and Ontario. Total volume is not likely to exceed 500 miles.

Liquid line construction for 1961 totals about 800 miles, of which 505 miles are concentrated in British Columbia. Requirements for 1962 are not shaping up in large figures.

Several local condensate lines probably will be built to connect fields to refineries. Interprovincial Pipe Line Co., it is understood, is contemplating a fairly substantial program of main line looping to provide additional capacity for expected increases in deliveries to Ontario refineries as national oil policy targets lead to larger consumption of domestic crude in this region.

No other projects are definitely in sight at present because the squeeze on Alberta crude oil production, between Saskatchewan on one side and the new B. C. pipeline on the other, will preclude any expansion in the Alberta producing rate. No significant discoveries have been made during the past year that will require pipeline connections of any material size or extent.

The year's most noted gas line projects, those of Alberta Gas Trunk Line and Alberta Natural Gas, were described in the November issue of PIPELINE ENGINEER.

Problems of Peace River

A principal job in 1961 was Peace River Oil Pipe Line Co. Ltd.'s 161-mile, 12-in. pipeline from Fox Creek to Edmonton to provide a transportation channel for condensate from Windfall wet gas field and to pick up small quantities of crude oil from intermediate fields on the way to Edmonton. In its early stages, it

Cradling pipe on the Peace River line into trench immediately following coating and wrapping.

represented one of the more difficult jobs of the season.

The contract was awarded following a rather sudden decision to proceed after a two-year delay since the original grant of the construction permit. The contractor was Banister Construction Co. Ltd.

The line runs generally east and a little south, with a few diversions, parallel to the main road. Approximately the first half of the route is through difficult terrain, consisting mostly of muskeg. Occasional swamps, bogs and small sloughs intersperse the rest of the route, but most of the easterly half is through rolling, cultivated farm land.

Timber growth is moderate to heavy in the westerly part of the route.

After welding kicked off on July 10, weather worsened with some rain every day. Experience in August was a little better, but no speed records were set on the job.

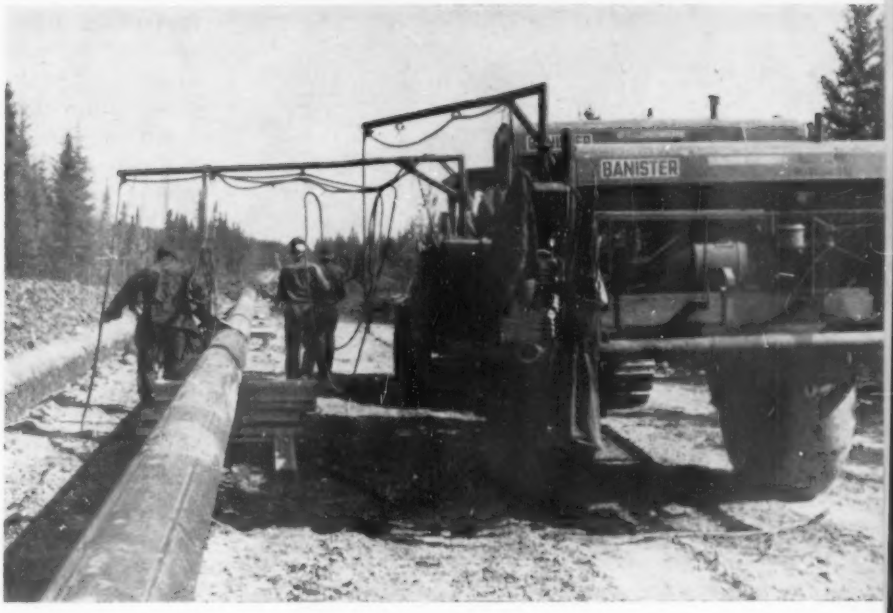
Biggest topographical feature on the route is the Iosegun River, a major waterway in northwestern Alberta. It presented a steep drop of 250 ft on the east bank. Several minor river and creek crossings occurred at other points. The largest, but not the most difficult, crossing was of the Athabasca River at Whitecourt. Although this river is wide, it is not deep and has shallow approaches on both banks, so it presented little problem in crossing. In the river and creek beds there were a few rock ledges that had to be drilled and shot but practically no rock in the ditch at any other point.

Timber supply for riprap was no problem, but during the wet period there was some difficulty with riprap floating on ground water. This was the period when most remedial work was required to repair places where riprap fell through. Even in dry weather, heavy machines of the pipe and dope gangs occasionally struck a soft place where there was no support under the riprap and tipped sideways, so that they had to be winched out.

The first half of the job was ditched almost entirely by backhoes, as many as 12 being on the spread at one time. For the rest of the route, where terrain is mostly heavy loam, clay and well-compacted sand two rotary ditchers were used for a large part of the distance. The backhoes worked from heavy timber mats nearly all the way on the first half, but generally could be walked through the low spots in the eastern part.

Only a few bored and cased road crossings had to be put in, as the line crossed the main blacktop road only twice. During the first half of the route there were few roads at right angles to the right-of-way. Most were secondary gravel or unimproved dirt roads that could be cut and backfilled. Coming through the Edmonton urban area, however, to the refinery tie-in at the east side of the city, there were several crossings of roads, rail lines and other pipelines.

The pipe gang did not average much more than a mile a day for the first month because of downtime for rain. Its best day recorded about 13,000 ft. Pipe was all in single joints,



Drilling rock on steep slope of Livingstone Range, one of most rugged parts of Alberta Rockies, on Savanna Creek line.

Hot pass welders on Peace River job using equipment mounted on swamp buggies.

random lengths averaging about 47 ft. Welding equipment included a quad unit mounted on a tractor for the two stringer bead welders. Hot pass welders had four 300-amp welding machines mounted on swamp buggies and towed by tractors. Six 200-amp welding machines on rubber-tired wagons and towed by tractors, were used on the firing line.

Coal-tar enamel was used for coating, and the pipe was cradled into the ditch immediately.

Because of absence of road crossings in the westerly half of the job tie-ins were fairly far apart, averaging only about two to the mile. However, the tie-in gangs were responsible for setting river weights, which was a big job. Reinforced concrete square set-on weights were used for many miles through muskeg, as well as split-collar bolt-on weights for the larger river crossings. For the first 15 miles to the Iosegun River, the line was weighted with almost continuous river weights to overcome effect of muskeg terrain and ground water, which was practically on the surface.

The Peace River line is designed to be integrated with the rest of the system, which previously consisted only of the direct line from the Sturgeon Lake area oil fields to the pumping station on the Trans Mountain main line at Edson. This line can deliver only for westward destinations, where marketing of Alberta crude will be restricted after the British Columbia interior oil pipeline goes on stream in the late fall. Thus the decision to build the new line to Edmonton provides the flexibility that will make it possible to divert crude movement for easterly destinations.

The Fox Creek starting point of the new line is at the pumping station at this point on the original line. The new line is intended to carry upward of 15,000 bpd of condensate and a variable quantity of crude oil, with initial throughput probably between 25.000 and 30,000 bpd.

A Tough Little-Inch

Probably the most difficult little-inch project of the past several years is the one that is related to but independent of the gas export project. It is Saratoga Processing Co. Ltd.'s 44-mile, 16-in. lateral in southwestern Alberta that will carry gas for export from Savanna Creek field in the vicinity of Plateau Mountain to the processing plant at Coleman, Alta. It was contracted to Banister Construction Co. Ltd.

The northern end of the line when completed will have involved the highest elevation to which a pipeline has ever been carried in Canada — 8132 ft to the top of Plateau Mountain where one of the Savanna Creek gas wells is situated.

Route of the line is partly in mountain country along the Livingstone Range, one of the most rugged and rocky parts of the Rocky Mountain Front Range in southwestern Alberta.

This job was kicked off in late winter, providing some time to get riprap down in the low spots while the ground was frozen. A moderate proportion of the route is through rock, but the

Backfilling a section of the Peace River line.

northern part largely is along the level Kananaskis Valley where ground is level to undulating glacial drift with a few steep shoulders of old river benches to go over. Rock is spotty and discontinuous at the south end, but at the north end the last few miles are almost solid rock along and up the flank of Plateau Mountain.

During the early part of the job, unusual snow conditions persisted, and the rivers went into spring flood conditions earlier than normal due to the sudden onset of warm weather at the end of May. During April and May it rained or snowed every day, and on May 10, 2 ft of snow fell in 24 hours, covering 4 ft on the level of old snow.

During the spring flood season there were 6 or 7 ft of water in rivers that run only a few inches deep in normal winter and summer low periods. Three exceedingly swift rivers had to be forded in the course of getting right-of-way: the Oldman, the Livingstone and the Racehorse which was crossed six times by the right-of-way. All have rock beds and are normally fordable by almost any vehicle, but in flood season the current runs so fast that it can easily sweep machines away.

Ditching was done entirely by backhoes, as there was not enough level ground in sand or clay soil to justify moving in rotary ditcher. The level stretches were mostly through glacial drift, with small to medium sized boulders that would have been hard on ditcher teeth. Ditch was cut to 6 ft depth normally, to provide for 3 ft of cover, with an additional 6 in. of soil padding in the rock ditch.

The pipe gang, kicking off on July 5, did well to average a mile a day. Normal standards of speed of movement went overboard on this job, because of very heavy grades requiring a lot of winching of heavy equipment.

An unusual backfill feature was the specification of sandbag dikes in the ditch in all places where there were long grades in areas of potential ground water circulation or where ground water might be expected to run off from cutbanks on side hills.

This job also contains one of the most difficult mountainside slopes ever encountered in pipelining in Canada. This is the last stage where the line has to climb up the sheer slope of Plateau Mountain on a grade that exceeds 60 deg. The length of this section is 3000 ft from top to bottom, with one ledge at 1000 ft from the top where pipe can be anchored.

Some Still in Progress

British Columbia is the scene of the largest crude oil pipeline job of the year — the 505-mile, 12-in. line of Western Pacific Products and Crude Oil Pipe Lines Ltd., a subsidiary of Westcoast Transmission. It will carry oil from northeastern B. C. fields to the Trans Mountain Oil Pipe Line Co. pumping station at Kamloops in the B. C. interior and provide the first outlet for production from these land-locked fields to refineries in the Vancouver area. Contractors are Canadian Bechtel Ltd. and Dutton-Williams Brothers Ltd.

In southern Alberta, two condensate pipelines are scheduled for construction before the end of 1961. One is Britamoil Pipe Line Co. Ltd.'s 65-mile, 12-in. from Rimbey wet gas field to Edmonton, and the other is a 27-mile, 4-in. from the new Wildcat Hills wet gas processing plant west of Calgary to a junction point on the Valley Pipe Line Co. Ltd. system south of Calgary.

Only awarded at the beginning of September was contract for an 88-mile, 14-in. loop of the Saskatchewan Power Corp. main line between Hatton gas field on the western boundary of the province and Success compressor station terminal which is a main junction on the province-wide grid system. Contractor is Robb Construction Co. Ltd.

Except for this one major gas transmission line loop in Saskatchewan, the eastern prairies and all of eastern Canada were devoid of any substantial construction jobs. Total mileage laid there was only about 100 miles, and it was in Ontario where Union Gas Co. of Canada Ltd. and Consumers Gas Co. Ltd. laid main transmission lines to provide service to a few communities not previously on their systems. ■

by J. E. Fairman

Cathodic Protection System Monitored by Aerial Patrol

When you patrol a pipeline by air, how can you at the same time obtain the information required to determine whether the cathodic protection is operating properly? This was the problem Southern California Gas Co. recently faced when it switched from truck patrol to aerial patrol of its 320-mile, desert, high pressure gas transmission system.

With routine truck patrol, pipe potentials with respect to buried rusty iron references had been measured at pre-selected locations on the cathodically protected lines. From these tests, pipe potentials with respect to a copper sulfate half cell could be calculated and the degree of applied cathodic protection determined.

From a leak patrol viewpoint, the new aerial system proved just as satisfactory as the truck patrol system, but no longer was the patrol readily able to obtain the information required to determine whether the cathodic protection system was operating properly. The company was forced to send out patrolmen for the express purpose of measuring pipe potentials which, because of the length of the protected system, proved expensive and difficult to schedule with other work. A more economical and dependable system had to be found.

Southern California Gas discussed this problem with engineers of Pipetron Co., North Hollywood manufacturer of a line of aerial survey indicators. Development of a self-contained signal device which would operate with no external power source, indicate a change in the pipe potential and be easily visible to the aerial patrol was required. The result is the system shown in the photographs.

The System, How It Works

A voltmeter connected between pipeline and buried magnesium electrode indicates the potential of the pipe with reference to the magnesium anode. As pipe potential varies beyond settable limits, contact points are closed in a circuit energized by solar cells. This actuates a solenoid, which releases a trip mechanism and causes a semaphore signal to change its position. The position of the semaphore indicates the change in pipe potential to the aerial patrol.

The semaphore signal device consists of two disks mounted to be visible to the aerial patrol. One side of the disk is red, the other side black. In "okay" position, the disks are at the same height with the red sides facing each other, thus appearing as a single black disk. When the device is actuated, one disk moves to a lower position and the two red sides are exposed. This is the "failed" indication. Once the semaphore moves to "failed" position, it remains there until it is reset, which is manually done at the control box.

Magnesium is used as a reference because of its high negative potential with respect to steel. This provides a reliable source of current for the potential sensing circuit even though the unit is installed in dry desert soil.

Solar cells were selected to provide power for the solenoid circuit as the units will be installed in remote areas where other sources of power are not available. Storage batteries could be used but would not have sufficient life expectancy and would require frequent changing.

When Is a Line Protected?

Southern California Gas considers a pipeline to be adequately protected when its potential with respect to a copper sulfate half cell is negative 0.85 v. Maximum potential should not exceed negative 2 v on coated lines due to the detrimental effect on the coating. To verify that this minimum potential is maintained, the company initially plans to install 11 semaphore units on the two pipelines protected by 10 rectifier sta-

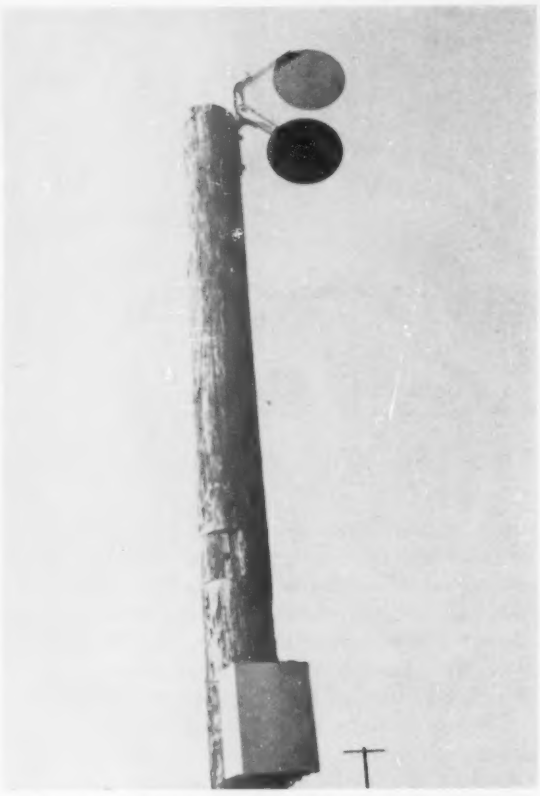


FIG. 1. Prototype of signal device now in operation.

FIG. 2. Control unit.

tions. Additional units will be installed if it appears desirable.

The units being installed are equipped with one settable limit which indicates when the minimum potential is not maintained. Available are units also equipped with a settable limit to indicate when a maximum potential is exceeded, but Southern California Gas does not feel these would be necessary with the protective system it has in operation.

One semaphore unit will be installed between each two rectifier stations and at other strategic locations. By accurately adjusting the setting at which the device is actuated, a drop in the protective potential of the pipeline to below the desired limit would be detected. This loss of potential could be caused by the output of either rectifier falling off, or by other conditions that might develop.

Fig. 1 is a prototype of the signal device now in operation. This unit was installed nearby in an accessible location so the company could observe its operation and make whatever tests it felt necessary. The solar cell can be seen several feet down from the top of the pole.

Fig. 2 shows the control unit for the device. One of the needles on the meter indicates the difference in potential between the magnesium and the protected pipeline. The other needle is the settable limit at which the device will be actuated. As the two needles come together, the contact points close and the semaphore signal is tripped.

Tests Southern California Gas has conducted so far indicate the device will accurately monitor its protective system. The firm believes the complete signal system will do the job without increasing the cost of its aerial patrol and at less than the present cost for sending out ground patrolmen.

About the Author

John E. Fairman has pioneered the development of deep ground beds for cathodic protection stations. As division corrosion engineer for Southern California Gas Co., he has participated in the design, operation and maintenance of cathodic protection for high pressure gas pipelines and related facilities. He has been associated with Southern California Gas for 14 years, five years of which have been in corrosion work. He studied at Los Angeles City College and Oregon State College.

■

by J. E. Rassmuss

South America: Scene of Surging Construction

Pipelining has reached such a fevered pitch in South America that now most of its countries can boast of present activities and of what's to come.

Argentina: scene of an 1100-mile gas pipeline, the most extensive system in South America, with a products line of almost equal length, and other extensive gas, crude and products lines projected.

Chile: 145 miles of new oil and gas lines in the Magellan fields, bringing the Southern Chile system to a total of 520 miles.

Brazil: a 298-mile, 12-in. crude oil line from Rio de Janeiro to Belo Horizonte now under construction.

Bolivia: the first trans-Andean pipeline in South America, crossing the Andes at an altitude of more than 14,000 ft.

Peru: a projected trans-Andean pipeline from the Amazon basin.

Ecuador: a proposed 60-mile pipeline from Libertad to Guyaquil.

Colombia: the country's first gas line, a 140-mile, 10-in. capable of transporting 20,000,000 cu ft per day, now under construction, and another with a capacity of 50,000,000 cu ft per day projected.

Venezuela: more than 1000 miles of gas lines now in operation, and new ones perhaps to be fostered by the activity of the new government Corporacion Venezolana del Petroleo.

Argentina

Argentina is the scene of South America's most extensive pipeline construction because of large oil deposits at Tierra del Fuego in the south, in the Salta Province near the Bolivian border in the north and in the Mendoza and Neuquen fields in the west.

Although crude from Comodoro Rivadavia, the largest oil field in the south, is shipped by tankers, a 1000-mile gas line connects the Comodoro field with Buenos Aires and a second 1000-mile gas line with a capacity of 350,000,000 cu ft daily is projected from Comodoro to Buenos Aires at an estimated cost of $300,000,000. A 250-mile gas line from the Neuquen fields in the west connects at General Conesa with the mainline from Comodoro.

Pipelines connect production of YPF, "Astra," "Diadema Argentina" (Shell subsidiary), and "Petroquimica" in the Comodoro Rivadavia area to Colonia Sarmiento; and Pan-American recently completed a 94-mile, 12 through 14-in. pipeline from its production at Anticlinal Grande to Caleta Cardoba. Capacity of the Pan-American line is 30,000 bpd.

In Tierra del Fuego, Tennessee Gas Transmission Co.'s subsidiary Tennessee Argentina recently opened a large oil field, and completed a 30-mile pipeline from Rio Chico to the Sara field, only five miles from the terminal on the

Maracaibo
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La Cruz
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Cartagena
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Bahia Blanca
Gral. Conesa
Rawson
Comodoro Rivadavia
Río Grande
LEGEND
OIL LINE
PROJECTED OIL LINE
GAS LINE
PROJECTED GAS LINE

Atlantic Coast from where the crude is shipped through a 3-mile submarine pipeline to Buenos Aires.

Major activity in Neuquen is the current construction of a $23,000,000 crude oil pipeline by Esso Argentina, subsidiary of Standard of New Jersey. From Challaco to Puerto Rosales near Bahia Blanca on the Atlantic, it will be a 394-mile, 14-in. and will cross two big rivers, the Rio Negro and Rio Colorado. Its capacity will be about 20,000 bpd initially and will be increased to twice that later.

The projected 680-mile pipeline from Mendoza, where YPF and Loeb Rhodes are operating, to Buenos Aires has been postponed because of high costs, but YPF reportedly will call for new bids.

The largest pipelines completed recently are those from Campo Duran on the Bolivian border in the north to the Rosario refinery on the Parana River and to Buenos Aires. They began operating in 1960.

Constructed by Fish Engineering Corp. of Houston and associates and Argentine contractors at a cost of $200,000,000, the 927-mile, 12-in. line was built from Campo Duran field to the refinery at San Lorenzo, north of Rosario. Nine pumping stations have been installed. It is designed as a products line, but also transports crude from the Bolivian Madrejones field. Capacity is 50,000 bpd.

The gas line from Campo Duran to Buenos Aires, 1083 miles long, running parallel to the other, has a diameter of 24 in. for a distance of nearly 1000 miles to San Nicolas and continues with 22 in. to Buenos Aires.

Finally, a gas line from Bahia Blanca, to be connected to the gas line from Comodoro, has been projected to Mar del Plata.

Chile

In Chile the pipeline system of the Magellan oilfields in the south totals 520 miles. Pipelines extend from the most southern field of Gaviota to Cullen, the biggest producer, then over the Chillan field to the embarking terminal of Caleta Clarencia. Branch lines extend to the Victoria, Sombrero, Manantiales and Calafate fields on Tierra de Fuego Island.

A 34-mile, 8-in. pipeline from Punta Delgada field north of Magellan Strait to the new Gregorio terminal will be extended farther east to the new Daniel field. The Punta Delgada-Gregorio line is paralleled by a 2-in. diam gas line.

A total of 145 miles of new oil and gas lines were built in 1960 by the Empresa Nacional del Petroleo in the Magellan fields.

Brazil

In Brazil pipelines are restricted to the Bahia area. Here, Agua Grande, Candeias and Don Joao fields, as well as some smaller fields, are connected by pipeline with the Mataripe refinery and the terminal of Madre de Deus in Bahia de Tados os Santos.

In the south, pipelines connect the port of Santos and Cubatao's Presidente Bernardes refinery, which has a 110,000 bpd capacity, with Sao Paulo; and the Duque de Caxias refinery north of Rio de Janeiro with the Isla de Agua terminal. Two 11-mile, 26-in. pipelines transport crude, and two 14-in. pipelines of the same length carry products.

Principal project under construction is a 298-mile, 12-in. crude oil line from Rio de Janeiro to Belo Horizonte, the capital of Minas Geraes. Costing an estimated $100,000,000, it will supply crude to the Belo Horizonte refinery. Capacity will be 25,000 bpd. Petrobras is the builder.

Bolivia

In Bolivia, where production is only about 9000 bpd, but prospects are promising, Yacimientos Petroliferos Fiscales Bolivianos has carried out an active and progressive expansion program, completing an extensive trans-Andean pipeline system.

The first pipeline built connects the Camiri field, YPFB's principal producer, with the refinery of Cochabamba. This 331-mile, 6⅝-in. line passes over an elevation of 11,000 ft. There are six pumping stations. A 4-in. branch line connects it with the refinery at Sucre.

Another, a 160-mile, 6-in. from Camiri to Yacuiba on the Argentine frontier connects with Argentine railways for export to Argentina.

A third, destined first for the transport of products, is a 243-mile, 6-in. climbing to an altitude of 14,000 ft. It was built by Williams Bros. Co. from Cochabamba to Oruro, principal mining center, and to the capital of La Paz.

From Sica Sica, a 218-mile, 8 and 10-in. line crosses the Cordillera at an altitude of more than 14,000 ft and then descends to sea level at the port of Arica. This line was completed by Williams Bros. in about a year at a cost of $12,000,000. The ascent requires only one pumping station, but the descent, which is by gravity, requires three back-pressure stations. It has been proposed to use the fall of the crude as petroelectric power.

Total distance from Camiri to Arica is nearly 800 miles. Initial capacity of 7000 bpd possibly

will be increased to 50,000 bpd with a second line from Sica Sica to Camiri.

Since its inauguration and initial filling with around 100,000 bbl of crude, this system has remained idle because of lack of production.

The recently discovered, apparently large oilfield of Caranda, being developed by Gulf Oil Co. of Bolivia some 30 miles northwest of Santa Cruz, may find an easier outlet to Brazil, with which Santa Cruz is already connected by railway. Then there is also an ambitious project by Petrobras of Brazil for a 1000-mile pipeline from Sao Paulo to Bolivia.

Santa Cruz has been connected to the Camiri field by a 4½-in., 160-mile line to supply crude to the new topping plant at Santa Cruz, from which products are shipped by tank car to Brazil.

YPFB by its ambitious program has succeeded in providing a large, well planned pipeline net in Bolivia, but one that exceeds present requirements.

Peru

In the northern coastal area of Peru only local pipelines connect the different oil fields of International Petroleum Co. and Cia. Petrolera Lobitos with the Talara refinery. Empresa Petrolera Fiscal ships its crude directly from the Organos field on the coast by a submerged pipeline.

Peruvian Pacific Petroleum Co., subsidiary of Cities Service and Richfield Corp., has a 6200-ft submarine pipeline linking its Humboldt 3-3, about 1000 ft deep and in 132 ft of water, with storage tanks on the coast. The same system has been successfully employed by Belco Petroleum Corp. for two underwater wells also drilled by the Richfield barge.

In the Peruvian Amazon Basin, short pipelines connect the two producing fields of Ganso Azul and Maquia with Pucallpa and Puerto Oriente on the Ucayali River, from where crude is shipped by barges to the Iquitos refinery in Peru and the Manaos refinery in Brazil.

Still far distant is a projected trans-Andean pipeline from the Amazon Basin over the lowest gap in the Cordillera at the Porculla pass at only 7000 ft. It can only be realized on the economic basis of a secured production of 100,000 bpd and proved adequate reserves.

Ecuador

On Ecuador's Santa Elena Peninsula, pipelines connect the Ancon field of Anglo Ecuadorian Oilfields Ltd. and Tennessee of Ecuador's Cautive and Tigre fields to the neighboring refineries of La Libertad and Cautive.

A proposed 60-mile pipeline from Libertad to Guyaquil has not yet been realized.

Colombia

Considerable extension of Colombia's pipeline system is being necessitated by the remote location of recent discoveries from the coast.

Two large trunk lines connect the De Mares concession in the Magdalena Valley and the Barco concession in the Maracaibo Basin on the Venezuelan boundary with the terminals of Mamonal, south of Cartegena and Covenas, in the Gulf of Morosquillo.

The 335-mile, 10-in. Andean pipeline from De Mares to Mamonal, with 285 miles of 10-in. and 20 miles of 12-in. loops, has attained a capacity of about 80,000 bpd. Eighteen stations pump the heavy crude.

In the lower Magdalena region, a 54-mile, 6 and 10-in. branch line connects the high grade Dificil field of Shell with the main line at El Plato. Two small 4-in. branch lines, 11 and 12 miles long, link International Petroleum Co.'s Totumal and Aguachica fields. Short branches connect the Casabe and Cantagallo fields of Shell in central Magdalena. A 16-mile continuation of the main line to Galan on the Magdalena River is operated by Empresa, the government company.

Texas Petroleum Co.'s 114-mile, 12-in. pipeline from its Velasquez field, farther up the Magdalena, to Galan, connecting with the Andean trunkline at that point, requires only one pumping station because of its natural gradient. Its capacity of 30,000 bpd has made possible full development of the field. A short branch line links the Palagua field, and a 46-mile, 4 and 6-in. pipeline connects La Dorado refinery, upstream on the Magdalena River. Finally, in the uppermost Magdalena basin in Tolima, a 21-mile, 4-in. connects Texas Petroleum's Tetuan field with its Guamo topping plant.

The other trunk line from Colombian Petroleum Co.'s (Mobil-Texas) Tibu and Petrolea fields in the Barco concession, a 262-mile, 12-in., rises from an altitude of 216 ft at Petrolea to over 5000 ft crossing the Sierra de Perija, then descends to sea level at the terminal of Covenas. It is served by three pumping stations and has a capacity of 27,000 bpd.

The Cicuco field, Colombian Petroleum's second largest, is linked by an 11-mile, 10-in. pipeline and is now the scene of Colombia's first gas line construction. It will be a 140-mile, 10-in., $6,000,000 pipeline transporting 20,000,000 cu ft of gas daily from the field to the principal port of Barranquilla.

Another gas line of 50,000,000 cu ft daily

capacity is projected from John W. Mecom's recently discovered gas field at Jobo to Cartagena for the petrochemical plant to be built by International.

Empresa has built a 241-mile, 6 and 8-in. products lines from Galan to supply Bogota.

A 123-mile, 6-in. branch line has been built from Puerto Berrio on the Magdalena River to Medellin.

The only pipeline from the Pacific Coast is the 63-mile, 6 to 8-in. products line from the port of Buenaventura to Cali, Western Colombia's largest city of 600,000 inhabitants. This $4,000,000 line has a capacity of nearly 30,000 bpd.

Projected are new products lines from Empresa's Barranca Bermeja refinery to Bucaramanga in the east and from Tibu to Cucuta on the Venezuelan boundary.

Venezuela

In Venezuela there are two principal pipeline nets, one in the Maracaibo Basin and the other in the eastern oil fields. The Apure Basin is connected by a pipeline from Barinas to Puerto Cabello.

In the Maracaibo Basin, Creole's 144-mile Ule Amuay line to the Amuay refinery on Paraguana Peninsula on the Caribbean coast is 24 to 26 in. in diam, with a capacity of 300,000 bpd.

A 30-in. trunk line of Shell extends from Lagunillas to Cabimas, with 400,000 bpd capacity and from that point there are two lines of 30 and 34 in. to Puerto Miranda at the entrance of Lake Maracaibo, with capacity increased to 800,000 bpd. Another 163-mile trunk line from Palmarejo transports crude from Shell's fields west of the lake to the Cardon refinery located also on Paraguana Peninsula.

A 16-in., 36-mile line transports heavy crude from Richmond's Boscan field to Punta Cabello, continuing under the lake to the eastern shore and later to Puerto Miranda. In the south of the lake a pipeline connects the Tarra fields near the Colombian boundary with the southern shore of Lake Maracaibo.

Numerous pipelines connect the lake's different fields, and under-water pipelines the wells in the lake. These are largely of aluminum pipe because of its resistance to corrosion.

In the eastern fields, one of the first pipelines was the 152-mile, 16-in. from the Mercedes fields to La Cruz. It has a capacity of 60,000 bpd.

From Oficina and Anzoategui fields several pipelines join at Anaco. From Anaco to the port of La Cruz there are two 60-mile, 16 and 26-in. lines, a third line of 30-in. from Oficina to Anaco and La Cruz, and, finally, a 6-in. gas line from Anaco to La Cruz.

From Sta. Barbara-Jusepin fields 10 to 16-in. lines extend to the refinery and terminal at Caripito, and from Travieso a 95-mile, 16-in. links La Cruz. From Monagas Temblador area a 92-mile, 30-in. line with a high viscosity crude capacity of 48,000 bpd has been completed to Caripito. Another line of 10-in. extends eastward to the western branch of the Orinoco River.

The Apure Basin, the third oil basin in Venezuela, has been connected by a 211-mile, 20-in. crude line from San Silvestre in Barinas to a terminal at El Palito west of the port of Puerto Cabello. Its capacity is 100,000 bpd.

In Southern Venezuela a 45-mile, 24-in. crude oil line is being completed from Phillips Petroleum Co.'s Morichal field west of Temblador in Monagas to a terminal on the southern bank of the Orinoco River west of Puerto Ordaz. Special provisions may be necessary for heating the extremely heavy crude.

Gas lines include: a 205-mile, 26-in. with a capacity of 220,000,000 cu ft daily from Anaco to Caracas; another which extends from Lechose in the state of Guarico north to the Caracas area, connecting with a line from Mercedes and extending west to Valencia, Puerto Cabello and Barquisimito; and one in the south connecting the Oficina area with Cuidad Bolivar and Puerto Ordaz on the Orinoco River.

Venezuela has nearly 2000 miles of 8 to 34-in. trunk lines, about 760 miles of branch lines connecting different fields and more than 1000 miles of gas lines.

About the Author

Dr. Juan E. Rassmuss is an independent consultant on South American oil development and geology, with offices in Lima, Peru. He received his PhD degree in geology from the University of Berlin. He was first contracted by the Argentine government. After having worked many years in Argentina and several other South American countries, particularly in Peru, he returned to Europe as manager and board member of an oil company in Rumania. After the entrance of the Russians in Rumania, he returned to Peru to conduct surveys of Peru's oil resources for the Peruvian government and to make surveys of Bolivia's oil fields for YPFB, that government's oil enterprise. ■

by Edward Gordon

Let's Play the Management Game In Gas Transmission

Take a personnel group, divide it into teams, give each team a hypothetical company — and, with the aid of a computer, you can teach gas transmission company management! You can play the management game!

This management game for the gas transmission industry is more than a "simplified" one. It actually simulates the industry, rather than just creating a dynamic situation in which the individual trainee plays a specific role. As a training tool developed by United Gas Corp., it adequately and vividly demonstrates the features peculiar to the gas transmission industry. Yet it retains the basic economic considerations common to most management games.

United Gas "game" takes into consideration: long-term contracts; financial structure of the capitalization of a gas transmission company; and regulatory agency control. This simulation is programmed for the Datatron 204 computer.

"Game of Chess" Principle

The value of a game situation for training purposes stems from the presence of competition. Opposing sides with conflicting interests try to outdo their competition. This provides the motivation so necessary to an effective training situation.

The military has used games for many generations to plan for future possible war situations, because rapidly changing technology does not permit the military to count on past battle situations. Chess is such a game, although not as sophisticated as modern war games.

In industry, too, rapidly changing and ever more complex technology and availability of modern electronic computers are leading to much greater interest in management games.

First management game comparable to modern war games was developed by the American Management Assn. in 1957. The Rand Corp., a leader in the development of war games during and since World War II, assisted. This first management game is based upon a model of a hypothetical manufacturing industry in which there can be up to five competitive manufacturers, each deciding how much money he wishes to spend on marketing and research, how many units of the product to manufacture, and the price to charge his customers. He can expand his production facilities or, if necessary, sell a portion of them. Each manufacturer makes independent decisions and is supplied with reports notifying him of the consequences of his own decisions and those of his competitors. This "simplified" model requires the use of an IBM 650 computer. It does not accurately simulate any specific industry.

Participants in management games become so involved, probably due to the stimulation of competition, that even weighty financial reports are analyzed avidly and thoroughly understood. Financial reports and other statistical summaries no longer are confusing arrays of uninteresting numbers. They tell the management of the strong points and weaknesses of the company being run and its competitors. The managers search for ways to improve and bolster their own company while gaining any advantage possible over their competitors. They quickly learn the ground rules of the management game, looking for loop-holes to turn into competitive advantages.

Basic Principles Taught

Management games are remarkably effective in teaching basic principles of economics and management. That is why more than 100 management games have been developed in the short time that has elapsed since the American

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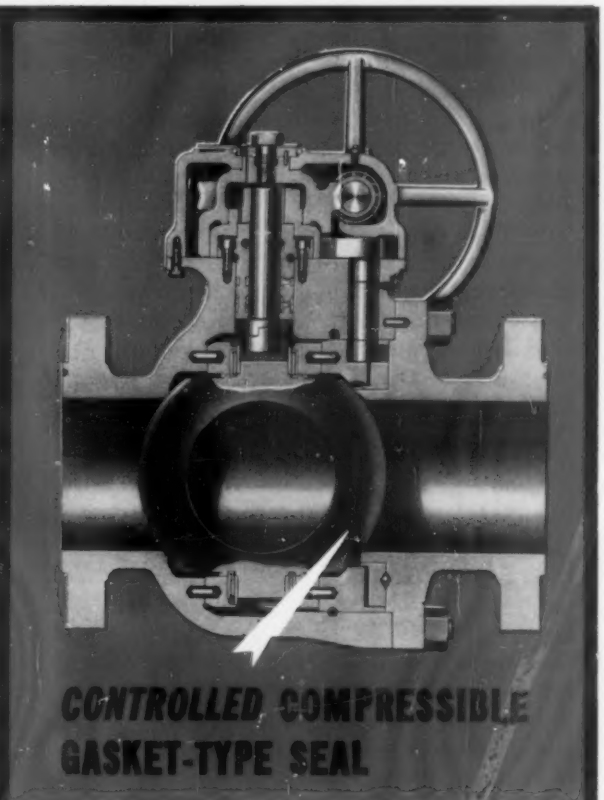

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Management Assn. game was first introduced just four years ago. These games vary widely in their content depending upon the objectives of the developers. Most of them have been developed by universities for use in their graduate and undergraduate level management courses.

One quickly learns that research and marketing expenditures and sales price influence demand for a product but that the effect depends upon what the competition is doing. Furthermore, the product must be manufactured economically so that the net effect is a profit to provide the funds necessary for healthy growth of the company. This narrow margin between revenues and expenses which we call profit leaves little room for expenditures to satisfy the desires of a single department that does not produce commensurate revenue. Furthermore, strategies should be long range with continuing reassessment of the competitive situation to detect the need for changes in long-range plans, to allow for the consequences of the plans of competitors.

Gas Transmission Variations

Although most industries do have the above characteristics, there are wide variations in their other characteristics. For example, in the natural gas transmission industry, gas purchases and sales are usually conducted under long term contracts. Thus, the competition is for new suppliers and customers and renewal of expiring contracts with present suppliers and customers. Hence, much greater foresight is required for new decisions to produce large effects and the resulting much greater significance of small effects.

Few commodities have a selling price on the order of one cent per pound. Yet, most pipelines sell their gas for less than one cent per pound. Consequently, huge volumes of gas must be transported at a very low cost despite tremendous investments in transmission equipment.

Because of the high capital investment required in the gas transmission industry with a return on investment limited by regulatory agencies to a level much lower than that of so-called manufacturing industries, much of the capitalization is obtained by sale of bonds. For many pipeline companies, the interest that must be paid to bondholders exceeds earnings of the owners of the company (the common stockholders). Thus the financial structure of the capitalization of a gas transmission company plays an important role in the economics of our industry. In the American Management Assn. game, as well as many others, only corporate earnings can be used to finance expansion. No other source of capital funds is provided in their management games. This is obviously inadequate for the gas transmission industry.

Another feature of the gas transmission industry is the presence of regulatory agency control over much of the gas sold. Unfortunately, many of the control principles are based on experiences of public utilities, which differ drastically from the characteristics of the gas transmission industry. For example, it is customary for gas sales prices set by regulatory agencies to be dependent upon the expenses actually incurred in a test period. With the transition from a limited demand far below the supply available to a demand comparable with the supply available, and taking into consideration the increased cost of finding gas, there has been a substantial increase in prices paid for new supply contracts to a level approaching that of competitive fuels.

Due to the long term nature of most gas supply contracts, the higher price of new supply contracts has resulted in substantial increases every year in the cost of gas purchased by pipelines. Thus, the price paid for gas by pipeline companies is significantly higher than the value used in determining the price to be paid by their customers, resulting in a return on investment significantly lower than the return the regulatory agency considers to be fair, which in turn is much lower than the return of other industries. Thus, this regulatory lag can have a rather serious effect when the cost of gas purchases is increasing rapidly as it has been doing for the past few years.

About the Author

Edward Gordon, as computer analyst at United Gas Corp.'s research laboratory, specializes in analysis of operating problems and research and development projects to make efficient use of available computational and experimental facilities in the solution of these problems. He holds a BChE degree from City College of New York and an MA in mathematics from the University of Southern California. His first association was with Shell Oil Co. at their Houston, Tex., refinery research laboratory. There, he worked on refinery process development which included a study of the decline in activity of cracking catalysts and a study of the efficiency and capacity of distillation columns. He also has served with the U. S. Navy and with Jet Propulsion Laboratory as senior research engineer.

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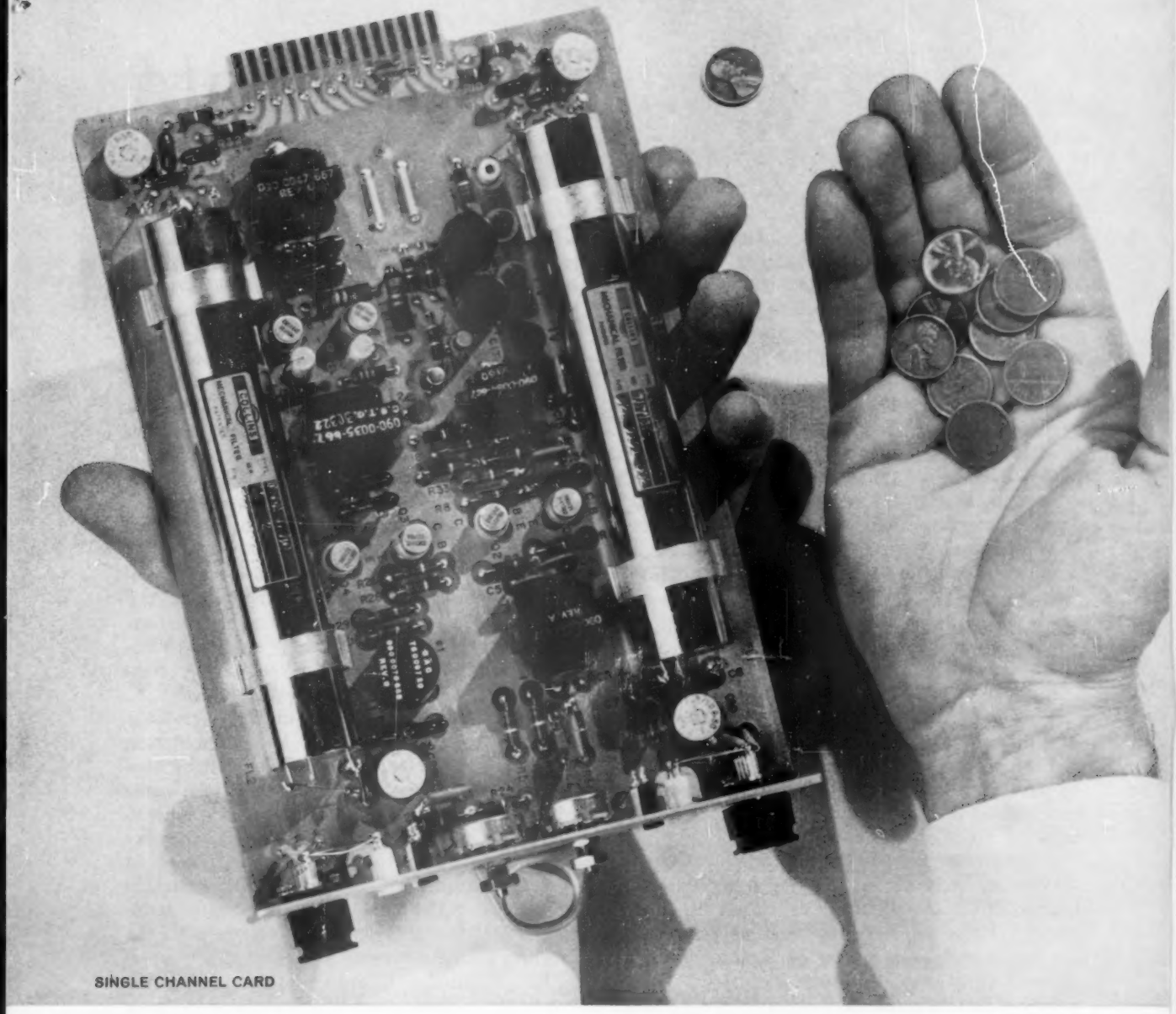

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by George H. Beck

After Data

Progress in pipeline operations technology has been closely linked with the industry's application of information-gathering techniques.

Today's data-logging systems will continue to be improved, but of even greater significance, many pipeliners believe, will be the application of computer control to system operations.

The evolution of such computer-controlled systems will be closely allied to advancements in data gathering and logging.

How has data logging progressed, and what is its present state? And what are some of the economic factors that might favor application of computers? Answers to these questions will help determine the future of computer applications.

Developments in Data Logging

Because of the nature of pipeline systems, it has been desirable since operations first began to obtain pressure and flow information from distant points so that corrective actions could be taken. In the early days this information was passed to the dispatcher by telegraph and later by voice or teletype.

Analog telemetering systems were placed in service as early as 1913. Early use of digital transmission techniques were used in tank gaging. These telemetering systems remain in use today and, as a matter of fact, are selling at the highest volume in their history.

These telemetering techniques are adequate and represent good engineering selections in certain operations. They will probably continue to be good investments for many years.

These techniques have one general fault, however, that makes them unsuitable for computer-controlled pipeline systems. They have little or no error proofing. Use of the human eye and mind provide the necessary error proofing.

The more sophisticated techniques of binary coded decimal data transmission have evolved from techniques used in supervisory control and computer systems. This equipment utilizes a system of coding that makes it mathematically improbable that an undetected error will be received as a valid message. Various methods of checking the accuracy of transmitted data are available. Their relative merits will not be discussed here. It is sufficient to say that these techniques produce highly reliable results.

As a result of the availability of reliable data transmission, automatic digital data logging systems have become available.

Results of recent surveys in the industry indicate the growing acceptance of binary coded decimal transmission and automatic digital data logging.

Design engineers and progressive management are looking forward to the day of the computer-controlled system. They have expressed their faith in its early arrival to the point of buying digital type equipment even now, when it may not always be justified.

Economic justification for digital equipment in almost every case is based on a combination type supervisory control and telemetering system being employed. Since much of the basic equipment is required for supervisory control, the additional cost of digital logging is only slightly more than the cost of analog recording systems. Additional communications circuits required for the analog system usually more than offset the difference in investment on the larger pipeline systems.

The additional incentive of preparing for computer control often tips the scales in favor of the digital type system.

"Off-Line" Computers

Many of these highly automatic data logging systems are installed on large pipeline systems and take a great volume of data. Unfortunately, most of this information is put to use for only a few minutes or hours at the most. It is then discarded or, worse still, stored in valuable files never to be referred to again.

Evaluation of these voluminous records by trained personnel to determine techniques for

Logging—What Next?

increased efficiency is economically impractical, but their evaluation is an ideal task for a general purpose computer. Evaluations of the record of previous operations can be quite valuable if proper limits are set on the results. Historical data is a valuable tool. Changes in operations that may result from such evaluations could, in themselves, pay many times the cost of a data search unit used on a part-time basis.

An "off-line" computer might perform several additional functions:

1. Scheduling.
   a. Proper sequencing of various products to provide minimum contamination.
   b. Checking for adequate storage at receiving points; coordination of schedules to meet batch size minimums at end points.
   c. Making calculations necessary for coordination of schedules with other carriers that must receive from the originating carrier.
   d. Preparing work schedules for partially attended operations having men on a "call-out" basis.
2. Computing optimum flow rates to meet a schedule as set up above.
3. Keeping track of batch changes and their expected arrivals at various points on a system.
4. Preparing forecasts of operating costs, income and required pipeline capacity.
5. Preparing stock or inventory reports.
6. General accounting and payroll functions.
7. Making market studies for economic analysis of pipeline extensions or additional marketing outlets along existing systems.

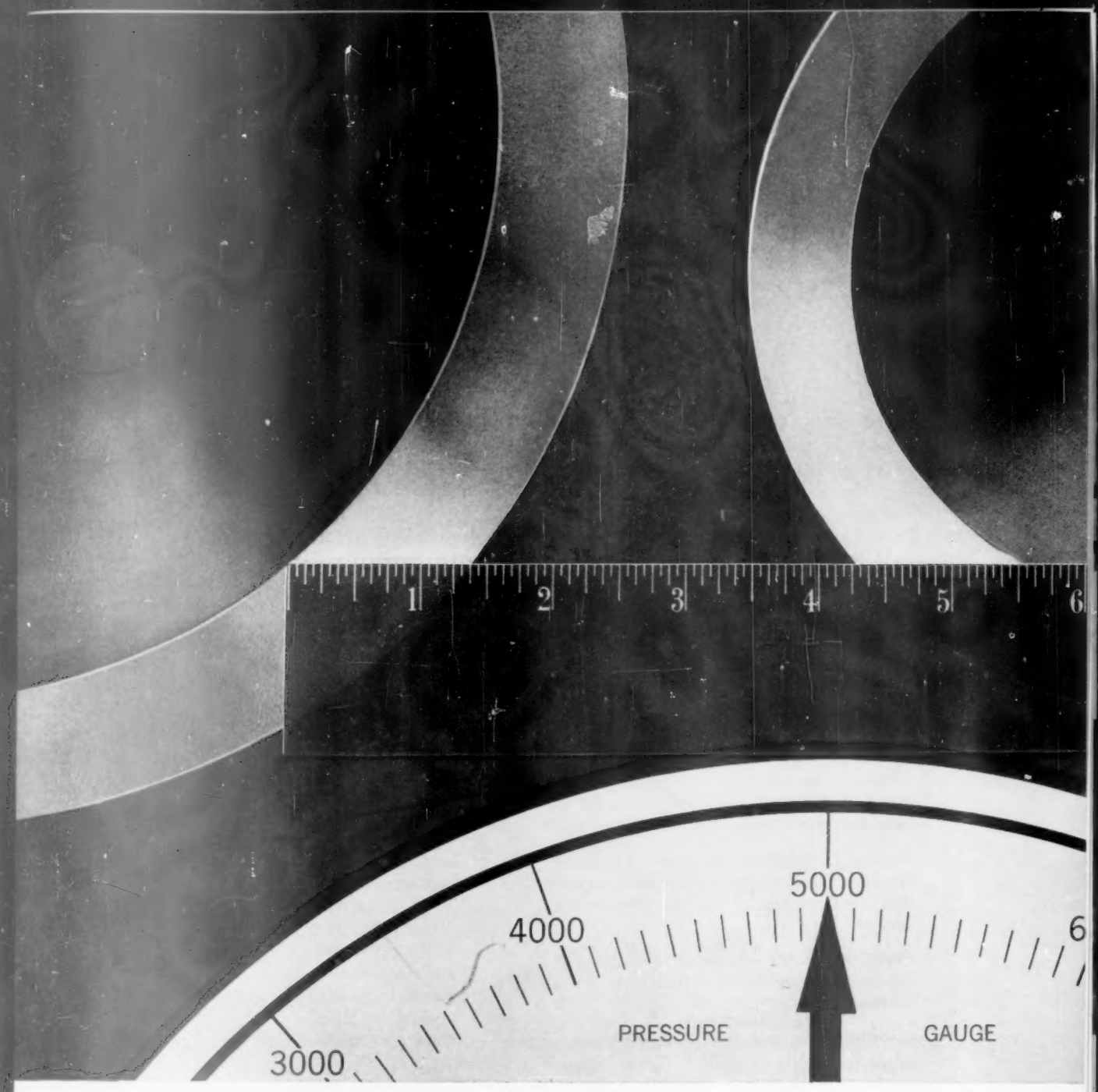
One important consideration when evaluating the requirement for an "off-line" computer is how readily the unit can be adapted to receive operating data from the pipeline. If possible, the digital code from the data logging system should be fed directly to the computer without the necessity of several translation units.

"On-Line" Computers

One giant step into computer operation of pipelines would be the application of special purpose computers to an entire pipeline system. The unit would receive basic data on market requirements and available supply and would work out a schedule and put it into action. While possibly the most desirable as the ultimate in automation, this system is least likely to be accepted by engineers and management, because it presents two major problems:

1. The cost of such a system probably would exceed any other system described here. In most cases, it would be so expensive, because of auxiliary equipment required, that its application would be impracticable. For this type of system to operate to its full capability in making decisions and putting them into operation, no valve would be opened by hand and no button pushed by hand, except those to provide basic information.
2. The other major problem will continue to be the high operating or investment cost of reliable communications. A communications failure under certain conditions could cause great loss of money. Designs to circumvent such occurrences are extremely costly.

Naturally, there is an economical point between present remote controlled systems and the ultimate system described briefly above. The adaptior of centralized "on-line" computer control to a limited degree is possible and will be produced in the next few years. The most likely installation will be on a pipeline system that now has a great deal of remote control and



It takes cannon-barrel pipe to store gas at 5,000 psi

North of the Susquehanna River near Renovo, Pennsylvania, is a depleted gas reservoir known as Leidy Field. It has just been converted into an underground gas storage field. The field has a total of 85 wells and is roughly 13 miles long and 7 miles wide.

To store gas in this natural reservoir when completed requires an injection pressure of 5,000 psi at the wellhead. This storage field provides for a peak withdrawal of 800 million cubic feet each day and an average withdrawal of 400 million cubic feet per day during the winter season.

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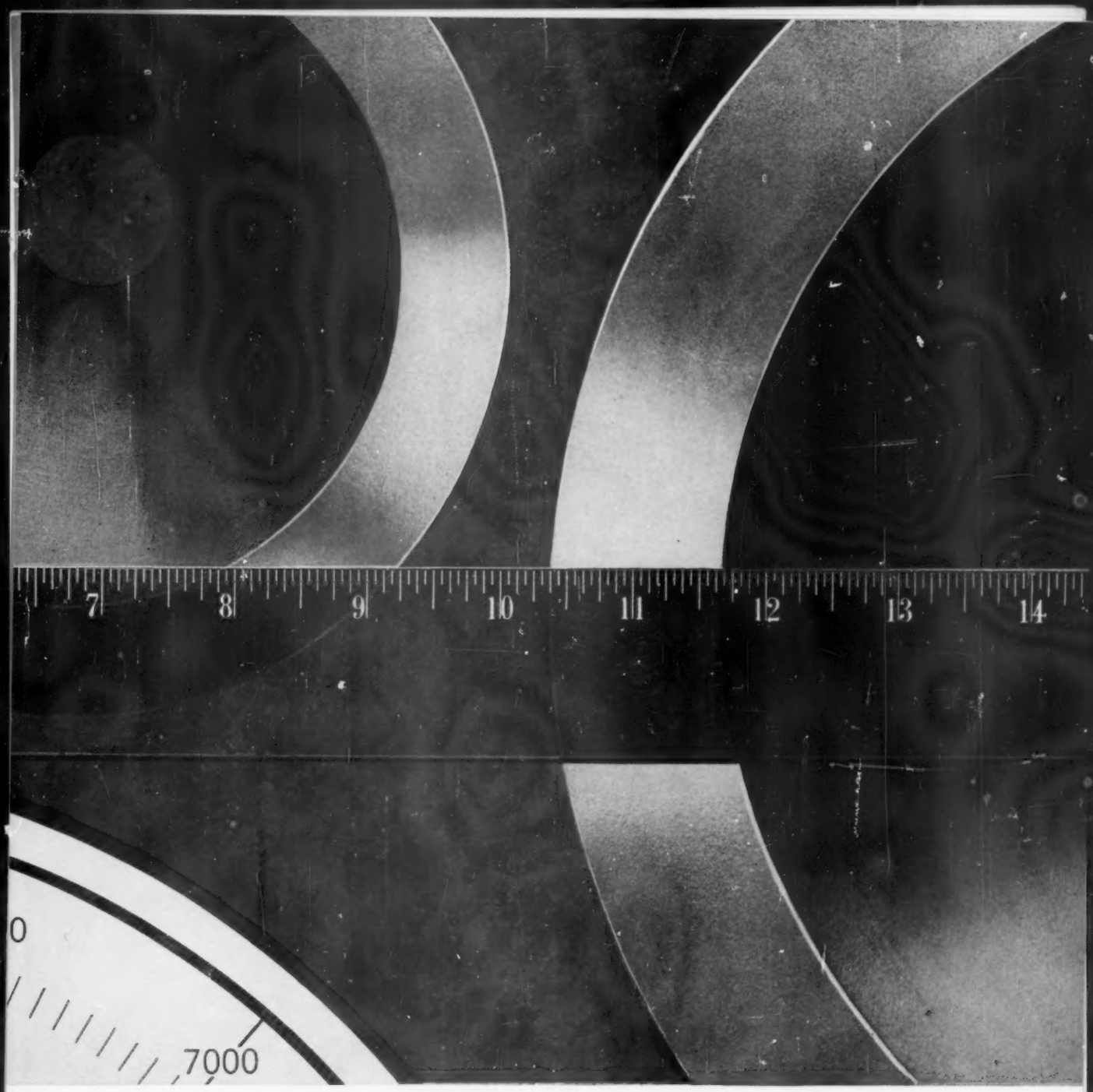

project, because the high pressures demanded strong, reliable pipe with almost cannon-barrel thickness. Pipe walls ranged up to 1.312″ in thickness in pipe size 6⅝-inch to 12¾-inch.

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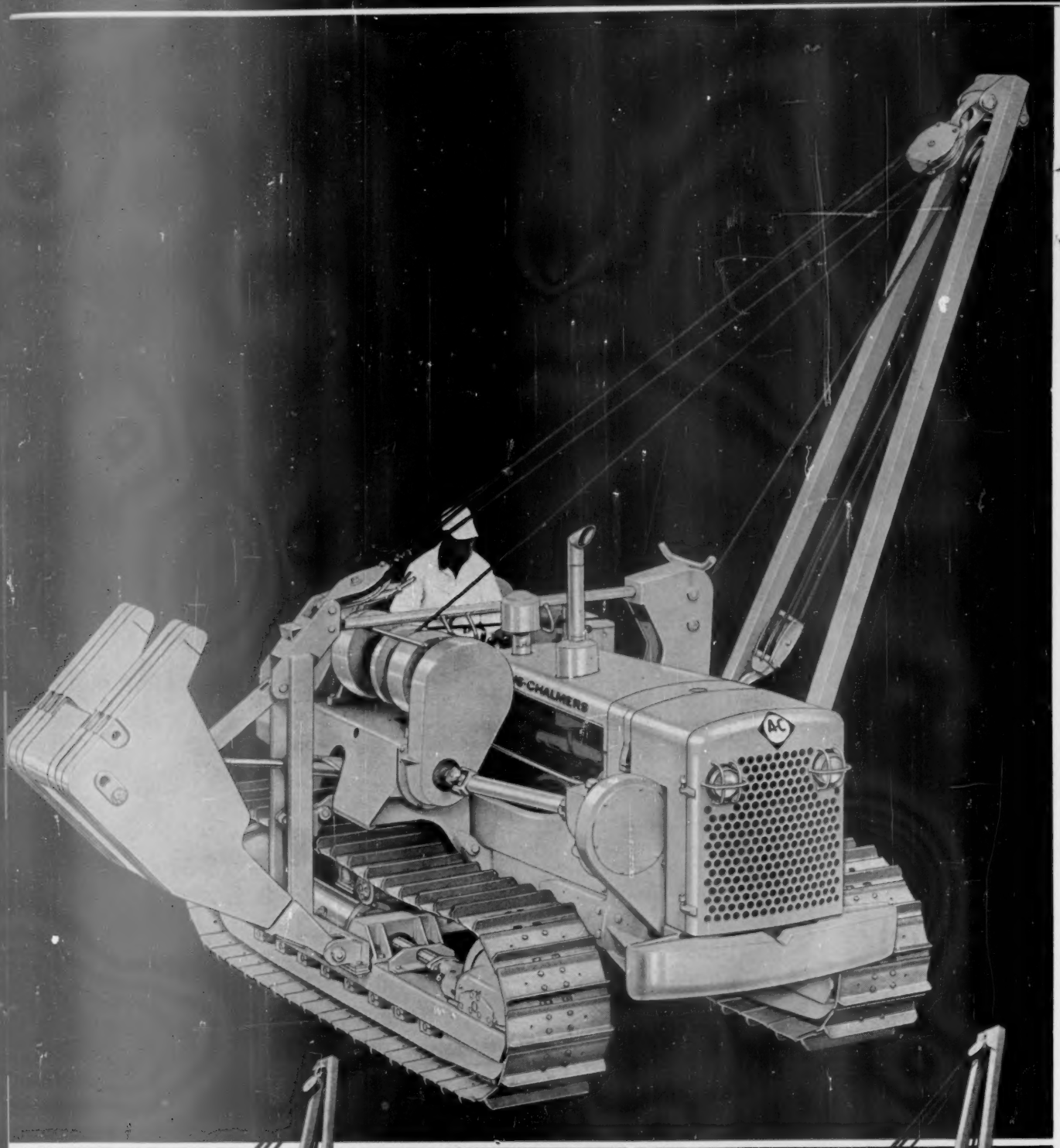

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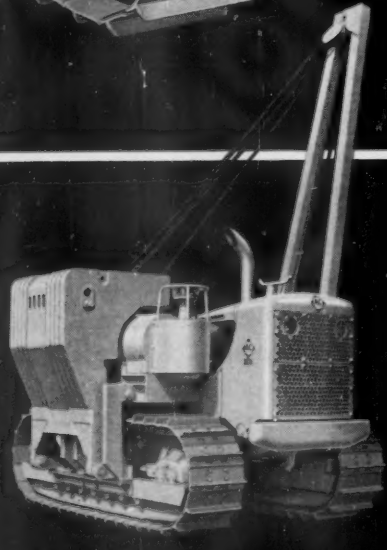

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Wherever you're using a side boom tractor in the 14- to 17-ton range —on medium-inch cross-country lines, small feeder lines, big-inch stringing work, oil or gas gathering lines—you can now get the advantages of torque converter drive with the new Allis-Chalmers HD-11. On cradling, stringing, hauling or dozing, this torque converter tractor will give you power and smoothness that no other tractor near its size can match in any terrain. In addition, with front power take-off, side boom is under full power control at all times.

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Weight: 35,000 lb with full counterweight
Hp: 111 net engine hp
Lifting capacity: 40,200 lb at 4-ft overhang

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Hp: 225 net engine hp
Lifting capacity: 127,000 lb at 4-ft overhang

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digital data logging equipment. There will still be considerable use of available override features on such a control system and some critical locations will continue to be manned.

The application of computers to "on-line" processes such as petroleum and chemical refining, in recent months, indicates that these devices are becoming highly reliable and relatively trouble-free devices. This development has occurred since the advent of "solid-state" computers. The reliability of a central computer control system will still depend a great deal upon the reliability of the communication system.

Local Computer Control

In recent years more attention has been given to the use of computer techniques at the local level to reduce power costs at individual stations. The earliest of these was the application of flow controllers to maintain constant flow at engine driven or electric pump stations. This was followed by the use of the "demand controller" to pumping station instrumentation at electric pump stations to reduce demand established while "packing-the-line" or to reduce the demand established by pumping heavy viscous fluids at the same flow rate as light, non-viscous fluids.

These systems were more fully utilized by a few companies with the addition of variable speed drives between constant speed electric motors and the pump. This made the "throttling" to conserve power (and money) more efficient.

A technique announced fairly recently is the use of computer logic to always run the correct number of individual pump units at a large electric multi-unit station. This enables the individual station to operate automatically at its most economical level.

The local computer approach is certainly one practical solution when large multi-unit electric stations are part of an existing pipeline system. It must be pointed out, however, that the most economical operation at each individual station might not be the most economical for the system as a whole.

So long as the operating levels are manually set with a minimum of calculations, it is to be expected that an extra margin of safety will be maintained. This margin will cause excess power consumption and/or reduced capacity for the system.

Application of similar principles to engine-driven stations or to electric drive stations with variable speed drives is not appreciably different, except in the complications introduced by additional non-linear functions caused by change in pump speed.

Other problems that might lend themselves to local computer control include:

1. Special hydraulic problems peculiar to a particular station that might best be solved with information obtained near the station.

2. Problems related to high viscosity crudes and the effect of temperature on their ability to be pumped.

3. Changes in operating units available due to local malfunction.

4. Power rates that allow special discounts for power used during power company off-peak periods.

There may be many more applications for these relatively low cost computers. It would certainly appear that this is a field that should not be neglected by the computer manufacturers.

"Combination" Computer Control

A concept recently introduced in natural gas pipelining is use of a combination computer control system. At each individual station a local control computer, perhaps similar to that described briefly here, would control the individual station.

An "off-line" computer at the dispatch center would receive information from the stations and from market and supply sources, make necessary calculations and present the schedule to the dispatcher. Obviously, the information could be directly fed from the master computer to the individual station computers without being checked by the dispatcher, if confidence in the system were high enough.

This approach is the most likely to be accepted by the liquid pipeline industry for its several advantages:

1. Communication circuit failure is no longer an intolerable problem, since the individual stations would have a memory and would not require constant supervision.

2. Computer equipment installed at the remote stations need not be identical. Simple translation units could provide any necessary changes in the command signals required.

3. Communication circuit requirements are

somewhat less costly, because less data is required to be transmitted and, therefore, either fewer circuits or less expensive circuits can be used.

4. The prime computer is available for other functions on a part-time basis.

5. The dispatcher can override the prime computer as required without losing the savings available with computer control, since each station still attempts to operate at its pre-set condition.

6. The system can be installed in increments. Individual station units can be installed one station at a time without the master computer. At the appropriate time the central computer can be added to complete the system.

7. A prime computer can be shared by more than one pipeline owned by the same company.

Economic Factors

It is not uncommon for a moderate sized liquid line to have power bills in excess of $1,000,000 per year. If 5% of this amount could be saved through better schedules, correct hydraulics and more efficient operations, the savings should make a good return on a computer system investment.

There are other possible benefits:

One or more tanks need not be built because of closer scheduling.

Possibly construction of booster stations could be delayed another year.

Perhaps line loop can be delayed.

All are substantial capital investments that may, in themselves, equal or exceed the cost of a computer system.

One pipeline company has found it economical to install a rather costly "off-line" general purpose computer to avoid adding dispatching personnel to its staff. There are other possible personnel savings through better scheduling of overtime, call-out time and maintenance time.

No attempt will be made in this article to show a "payout" on a computer system. A set of artificial conditions could be established, a price of installation suggested, and a "payout" be calculated. As every problem is not the same, this would serve little purpose.

Each company has its own operating methods, operating personnel, power and base investment costs, system capacity, market problems, supply problems and the many other things that make pipeline operations a diverse and exciting business. All of these factors enter into the analysis of the need for a computer system. A detailed study of the operation by experienced personnel is necessary to arrive at a realistic answer to the question — should a computer system be installed?

It must be assumed that many pipeline systems cannot justify economically the cost of a computer system at this time. It is almost as certain that some of the pipeline companies should be planning their installation now.

Conclusions

Engineers and managers should not enter into the use of a "combination" computer system, or any other type system, without thoroughly investigating their ultimate goals. The engineer has a responsibility to see that equipment now being installed is adaptable to the overall program. The manager's duty is to attend to the formulation of the plans, in conjunction with his staff, and to see that they are enacted.

Perhaps the greatest single obstacle to successful application of a computer to pipeline operations is reluctance to trust anything not understood.

A computer, as another tool to build a better system, is not magic — it is just new. As with other types of equipment, specialists are available to help you use this new tool.

A computer specialist can do a complete job for you if given enough time and information, but he must, in most cases, learn the rather broad field of pipeline operation. You need only to learn enough about the capabilities of computer equipment to present problems to it in a usable form.

In considering computer controls, the pipeline industry now faces a dilemma not unlike the one it has been facing in the use of automatic or remote control.

For those who apply themselves to these new problems and solve them, the answer to the question of "What comes after data logging?" will be "computer controlled pipelines."

Based on a paper presented at the Instrument Society of America Instrument and Automation Conference, St. Louis, Missouri.

About the Author

George Beck, since joining Williams Brothers Co. as a senior engineer in 1960, has been in charge of mechanical design for Mid-America Pipeline and project design for Calnev Pipe Line. Formerly, he performed electrical and mechanical design for Continental Pipe Line Co. When he received his BSME from Oklahoma State University in 1950, he joined General Electric Co. Beck is a registered professional engineer in Oklahoma and a member of AIEE.

■

Coming Construction

To Carry Heavy Crude Mix

Blackfoot Hills Pipelines Ltd. has filed a proposal with the Alberta Government to lay a transmission line for heavy crude and condensate in a mixed stream from the Lloydminster oil field to the Hardisty pumping station on Interprovincial Pipe Line Co.'s main line.

Actually, the proposal covers two pipelines. One will carry condensate from the foothills area fields to the Lloydminster area where it will be blended with the heavy crude. The mix will then be transmitted to Hardisty in the second line. The main line is designed for a 12,500 bpd capacity.

Pipelining the heavy viscous Lloydminster crude has never before been considered feasible, but the Alberta Research Council has indicated commercial possibilities in mixing with a very light oil.

Helium Line Bids Expected

Bureau of Mines of the United States Dept. of Interior will ask for bids soon on helium pipelines from the new Bushton, Kan., plant to Amarillo, Tex., storage. Cost is estimated between $8,000,000 and $9,000,000. Handling the project is the Bureau office at 514 Barfield Bldg., Amarillo. Williams Brothers Co. is consulting engineer.

Oregon Line Possible

Southern Pacific Pipe Lines Inc. is exploring the possibilities of building an oil and gas pipeline from Portland to Albany and Eugene, Ore.

According to the pipeline firm's parent, Southern Pacific Railroad, the line would follow the railroad's right-of-way through Western Oregon, with outlets "wherever there is a market."

Ala.-Fla. Line Loop Okayed

United Gas Pipe Line Co. has won Federal Power Commission approval of facilities to provide additional gas in the Pensacola, Fla., area.

The firm will build about 40 miles of 24-in. loop in two phases of its Mobile, Ala.-Pensacola line. The first project involves 21 miles of line from Escambia County, Fla., to Baldwin County, Ala. Not scheduled for construction until 1962 is a 19-mile segment westward into Baldwin County from the termination point of the 1961 construction.

Total cost of facilities will be about $3,871,430.

UGPL has permission also to construct about 10 miles of 30-in. loop in Terrebonne and Assumption parishes, La., at a cost of $1,959,900.

Worsley Line Deferred

The Alberta Oil and Gas Conservation Board has deferred the permit application of Westcoast Transmission Co. Ltd. to remove gas from the Worsley field in Northwestern Alberta. This action affects the building of a 40-mile pipeline to the British Columbia border by Alberta Gas Trunk Line Co. Ltd.

Grounds for deferment presented by Premier Steel Mills Ltd. of Edmonton were that operation of a smelter and a steel mill on a large iron ore reserve only three miles from the field would require all available gas.

The board, however, has granted permission to remove 15 MMcfd of gas from the Boundary Lake South field, one mile from the British Columbia boundary. Westcoast has applied to the National Energy Board for permission to build a pipeline across the provincial boundary for this gas.

Libya Line Planned

Standard Oil Co. (New Jersey) plans a pipeline in Libya, North Africa, to connect the Raguba oil field in concession 20 in the Cyrenaican Desert with the Zelten field pipeline. This line will provide an additional 50,000 bpd of crude oil from Raguba through Port Brega in 1963.

Will Spend Millions in 1962

Construction program of Texas Eastern Transmission Corp., Houston, Tex., for this year and 1962 involves expenditures of about $138,000,000. The company seeks registration of $35,000,000 of first mortgage pipeline bonds, due 1981, with terms to be specified later. Net proceeds will be used to retire outstanding revolving credit notes incurred for general corporate purposes including construction. Balance will be used in connection with construction program mentioned above.

ENI Group to Build S.A. Line

The Italian consortium of SAIPEM-SIDEREXPORT (Societa Anomina Italiana Perforzaioni e Montaggi), an ENI subsidiary, will build a 1066-mile, 30-in. pipeline for Gas del Estado of Buenos Aires, Argentina, if the Italian government approves long-term financing.

The previously announced $200,000,000 line will provide 53,000,000 cu ft of gas daily to the new industrial area of Olavarria by April 1962, 176,000,000 cu ft to Buenos Aires by the end of 1964, and 247,000,000 cu ft by the end of 1965.

FPC Filings

American Louisiana Pipe Line Co., Detroit, Mich., CP 62-94, filed Oct. 12, 1961. *Construction:* 27.1 miles of 4½-8 in. gathering lines, purchase meter station and 660-hp field compression facilities in Holly Ridge area, Tensas Parish, La.

Cost: $1,125,000 which includes: pipelines, $701,890; meter station, $25,000; 660-hp unit, $285,000; omissions and contingencies, $51,000; engineering, $35,000; organization and management, $10,000; interest, $17,000.

Arkansas Louisiana Gas Co., Shreveport, La., CP 62-77, filed Sept. 25, 1961. *Construction:* gathering, compressor and metering facilities during 1962.

Cost: $6,514,500 total which includes $1,883,500 in Oklahoma and Kansas and $4,631,000 in Arkansas, Louisiana and Texas. Of the total, $1,335,000 represents investment in field compressors. The remaining includes: land rights and rights-of-way, $148,500; structures, $122,000; gathering lines and measuring and

regulating facilities, $820,500; purification and other equipment, $167,000; transmission land rights, $222,500; structures and improvements, $17,000; rights-of-way for mains, construction and materials, $3,343,000; compressor station and main line measuring and regulating equipment, $188,000; other equipment, $151,000.

Columbia Gulf Transmission Co., Houston, Tex., CP 62-89, filed Oct. 9, 1961. *Construction:* 391 miles of 30-in. loops and engine-compressor additions totaling 79,900 hp. (related to Monterey project.) In 1962, firm will build: 13.3 miles in Rowan and Corker counties, Ky.; 16.9 miles in Lincoln, Garrard and Madison counties, Ky.; 4.7 miles in Metcalfe County, Ky.; 15.1 miles in Williams and Davidson counties, Tenn.; 17.2 miles in Wayne County, Tenn.; 23.5 miles in Union and Tippah counties, Miss.; 17.6 miles in Carroll and Grenada counties, Miss.; 10.9 miles in Issaquena, Washington and Sharkey counties, Miss.; 13.5 miles in Franklin Parish, La.; piping connections in Rapides Parish, La.; Tennessee River crossing in Hardin County, Tenn. In 1963—141.6 miles of 30-in. in Carter, Madison, Metcalfe and Adair counties, Ky.; Davidson, Wilson, Wayne and Lewis counties, Tenn.; Tippah, Prentiss, Alcorn, Grenada, Yalobusha, Sharkey, Washington and Humphreys counties, Miss.; and Franklin and Rapides parishes, La. In 1964 — 36.1 miles of 30-in. in Carter and Adair counties, Ky.; Lewis County, Tenn.; Yalobusha County, Miss.; and Franklin Parish, La.; and eight compressor stations in Powell County, Ky.; Macon and Maury counties, Tenn.; Alcorn, Calhoun and Humphreys counties, Miss.; and Richland and Rapides parishes, La. In 1965 — 80.6 miles of 30-in. in Carterm Boyd, Madison, Estill and Adair counties, Ky.; Wilson, Sumner, Trousdale and Lewis counties, Tenn.; Alcorn, Yalobusha, Humphreys and Sunflower counties, Miss.; Catahoula and Franklin parishes, La.; and crossings of Cumberland and Kentucky rivers.

Cost: $67,355,400 total which includes: in 1962, $16,800,100; in 1963, $18,903,800; in 1964, $18,253,200; and in 1965, $11,412,400.

Monterey Gas Transmission Co., Houston, Tex., CP 62-88, filed Oct. 9, 1961. *Construction:* 216-mile, 30-in. from Clear Lake, Tex., to compressor station 9 near Alexandria, La., as well as metering and regulating facilities near Alexandria and the King Ranch plant, by Nov. 1, 1962. Also, an 8500-hp compressor station (No. 2) in Newton County, Tex., by Nov. 1, 1964, and an 8500-hp compressor station (No. 4) in Brazoria County, Tex., in 1965. Also, acquisition of Humble leasehold interests to 329.8-mile pipeline in Texas (gathering line in Viboras and North Alazan fields, Laguna Larga and South Santa Fe fields) and a 238-mile, 30-in. main line from King Ranch plant to Clear Lake, Tex.

Cost: $27,070,000 for acquisition; and $32,760,000 for construction ($28,620,000 in 1962, $2,041,000 in 1964, $2,099,000 in 1965).

Natural Gas Pipeline Co. of America, Chicago, Ill., CP 62-87, filed Oct. 9, 1961. *Construction:* side taps on transmission system, meter stations and lateral branch lines during 1962.

Cost: not to exceed $3,500,000, with any facilities required in any one area not to exceed $500,000. Cost breakdown as follows: 167 miles of 6-in., $2,934,000 (material, $1,625,700; installation, $1,308,300); twenty-nine 6-in. or equivalent purchase meter stations, $243,000 (material, $123,000; installation, $120,000); nineteen 4-in. or equal side taps, $34,000 (material, $16,000; installation, $18,000); engineering, general, administrative, $80,000; interest, $43,000; contingencies, $166,000.

Texas Eastern Transmission Corp., Houston, Tex., CP 62-81, filed Sept. 27, 1961. *Construction:* 23-mile, 14-in. from Sligo field, Bossier Parish, La., to 24-in. Provident City-Castor in Red River Parish.

Cost: $1,291,000 which includes: general plant, $25,000; certificate, $10,000; survey, $10,350; right-of-way and damages, $88,320; pipe, $497,025; five 14-in. ASA 600 gate valves, $21,500; 14-in. ASA 600 check valve, $1840; six 6-in. by 4-in. ASA 600 gate valves, $4260; 23 miles of coating, $36,800; 1000 ft of 20-in. casing, $5670; installation, $501, 952 ($101,200, company portion; $400,752, contract portion); and contingencies, $60,000.

Transcontinental Gas Pipe Line Corp., Houston, Tex., CP 62-86, filed Oct. 4, 1961. *Construction:* 189.11 miles of main line in Texas, Louisiana, Mississippi, Alabama, Georgia, South Carolina, Virginia, Maryland and Pennsylvania at a cost of $27,006,540; additional horsepower at 13 compressor stations at a cost of $12,092,900; 9.51 miles of 24-in. and 18.71 miles of 20-in. gathering lines in Central Louisiana at a cost of $3,085,002; McMullen gathering system, new intermediate compressor stations and 4320 hp at station 10 at a cost of $1,201,000; distribution meter and regulator stations, $89,950; franchise and consents, $108,600; overheads, $937,000; interest, $2,210,000; contingencies, $2,269,008. Total is $49,000,000.

CP 62-107, filed Oct. 27, 1961. *Construction:* additional meter station at Hudson County, N.J.

Cost: $22,000 which includes: land in fee, $350; yard improvements, $1000; building and foundations, $3358; measuring and regulating equipment, $13,954; field engineering, supervision, $886; franchise, consents, $300; general overheads, $427; interest, $608; contingencies, $1117.

United Fuel Gas Co. and Kentucky Gas Transmission Corp., Charleston, W. Va., CP 62-90, filed Oct. 9, 1961. (Related to Monterey project.) *Construction:* In 1962 United will build 7.9 miles of 26-in. loop in Putnam County, W. Va., and add 1600 hp at Ceredo station near Huntington, W. Va., while Kentucky Gas will build 7.9 miles of 30-in. in Montgomery County, Ky. In 1963 7.7 miles of 20-in. in Kanakwah and Roane counties, W. Va., and an additional 3200 hp to Ceredo station by United, and 8 miles of 30-in. in Bath County, Ky., and 880 hp added to Means station by Kentucky Gas. In 1964 4.5 miles of 30-in. near Kenora station, 2800-hp additions to both Ceredo and Lanham stations and 1100-hp addition to Glenville station (Gilmer County, W. Va.) by United, and 9.6 miles of 30-in. in Bath and Nickolas counties, Ky., by Kentucky Gas. In 1965 2.8 miles of 20-in. near Glenville station, 4.3 miles of 30-in. in Putnam County, W. Va., 2800-hp additions to both Ceredo and Lanham stations and activation of storage pool designed for initial injection during summer of 1966 by United, and 880-hp addition to Means station near Camargo, Ky., by Kentucky Gas.

Cost: $21,771,400 total as follows: in 1962 $985,500 for pipe and $320,000 for horsepower by United, and $1,157,400 for pipe by Kentucky Gas; in 1963 $1,218,500 for pipe and $640,000 for hp by United, and $1,196,400 for pipe and $325,000 for hp by Kentucky Gas; in 1964 $731,500 for pipe and $2,845,000 for hp by United, and $1,387,900 for pipe by Kentucky Gas; in 1965 $886,300 for pipe, $1,960,000 for hp and $7,738,900 for storage by United, and $352,000 for hp by Kentucky Gas.

Pipeline Contractors

Brown & Root Inc., Box 3, Houston, Tex. *American Petrofina Co.* — 133-mile, 6-in. products line from Mt. Pleasant to Grapevine, Tex. Fowler-Tatom Inc. has been sub-contracted 80 miles.

O. R. Burden Construction Corp., Box 5216, Tulsa, Okla. *Texas Eastman Co.* — 207 miles of 275-mile, 6-in. from Longview, Tex., to salt dome storage facilities of Phillips Petroleum Co. at Clemens Dome near Sweeny, Brazoria County, Tex.

R. H. Fulton & Co., Box 1526, Lubbock, Tex. *Continental Pipe Line Co.*—550 miles of 2, 3, 4, 6 and 8-in. in Montana (field office in Cut Bank) and Wyoming. Red Mitcham is superintendent.

Hall Construction Co., 1105 N. Carlton, Liberal, Kan. *Panhandle Eastern Pipe Line Co.*—a 330-mile, 4 through 12-in. gathering system in western Kansas. Supervising are Mike Bell and M. E. Banning.

Houston Contracting Co., 2807 Buffalo Speedway, Houston 6, Tex. *Transcontinental Gas Pipe Line Corp.*—66 miles of 30 and 36-in. in four loops from Fulshear, Tex., to New Roads, La. Superintendent: M. L. Thompson, assisted by Talmade Crabtree. Field office manager: G. A. Warner.

Dixie Pipeline Co. — 226 miles of 30-in. from Mont Belvieu, Tex., to Baton Rouge, La. R. R. Lytle is superintendent of one spread, with L. F. Redfearn as office manager. R. R. Rice is superintendent of a second spread, with Jack Hensley as office manager.

Texas Gas Transmission Corp. — 60 miles of 26 and 30-in. from Memphis, Tenn., to Lafayette, La. Superintendent: A. J. Slovack, assisted by L. L. Patterson. Office manager: B. C. Sweeney. Also, 52 miles of 8, 16 and 20-in. from Bay Round to Morgan City, La. Superintendent: R. E. Thornton. Office manager: S. B. Harrison.

Trunkline Gas Co. — 18 miles of 30-in. near Epps, La. Superintendent: L. A. Young, assisted by Kurt Berlin. Office manager: Joe Puckett.

C. S. LeNoir Construction Co., Box 798, Austin, Tex. *United Gas Pipe Line Co.* — 20.5 miles of 24-in. (17 miles in Baldwin County, Ala., and 3.5 miles in Escambia County, Fla.) Superintendent: W. B. Williams.

Majestic Contractors Ltd., 49 Jackes Ave., Toronto 7, Ont., Canada. *Gas Trunk Line of British Columbia Ltd.*—29 miles of 16-in., 15 miles of 12-in., 2½ miles of 6-in. and 1 mile of 4-in. in Blueberry, B. C. area. Field offices: Fort St. John, B. C., and Mile 114½ Alaska Hwy. Superintendent: George Oswald.

Interprovincial Pipe Line Co. Ltd. and Lakehead Pipe Line Inc.—Niagara River crossing (west branch) from Ontario to New York.

O. L. Olsen Co. Inc., 416 Pierce St., Houston, Tex. *Tennessee Gas Pipeline Co.* — 5500-hp compressor station in DeKalb, Miss.

Panama, Inc., 1801 Tennessee Bldg., Houston 2, Tex. *United Gas Pipe Line Co.* — 60 miles of 36-in. offshore Louisiana, 60 miles of 30-in. out of Breaux Bridge, La., and 60 miles of 30-in. out of West Monroe, La.

Pioneer Pipeline Contractors Ltd., Calgary, Alta., and Fort St. John, B.C. *British Columbia Oil Transmission Co. Ltd.*—66 miles of 8-in. main line and 11 miles of 4-in. gathering line to connect Blueberry field with Taylor, B.C.

H. C. Price Co., Pipe Coating Div., Price Tower, Bartlesville, Okla. *Shell Oil Co.*—Somastic coating of 52,000 ft of 6-in. Headquarters: Harvey, La. Superintendents: L. C. Carle and V. J. Jones.

Shell Pipe Line Corp. — Somastic to 8 miles of 12-in., 1 mile of 10-in. and 1 mile of 8-in., as well as Somastic and Hevicote to 3 miles of 12-in. Headquarters: Harvey, La. Superintendents: L. C. Carle and V. J. Jones.

United Gas Pipe Line Co. — Somastic and Hevicote to 17 miles of 20-in. Headquarters: Harvey, La. Superintendents: L. C. Carle and V. J. Jones.

S.A.I.P.E.M., Casella Postale 4159, Milan, Italy. *Oil India Private, Ltd.*—720 miles of 14, 16 and 18-in. from Nahorkatiya to Barauni.

Baghdad, Iraq, Ministry of Industry — 56 miles of 10, 14 and 18-in. from Rumaila to Basrah.

SNAM (Oleodotti Internazionali) — 118 miles of 24 and 26-in. from Genoa to Ponte Tresa; 53 miles of 22 and 24-in. from Ponte Tresa to S. Bernardino; 90 miles of 22-in. from S. Bernardino to St. Margrethen.

Sharman, Allen, Gay & Taylor Inc., Box 13152, Houston, Tex. *Trunkline Gas Co.* — 22-mile, 30-in. between Senatobia, Miss., where headquarters is located, and Bahalia. E. D. Singleton is superintendent.

Sheehan Pipe Line Construction Co., 514 National Bank of Tulsa Bldg., Tulsa, Okla. *Transwestern Pipeline Co.* — has underway an additional 100 miles on the 4, 6 and 8-in. gathering system in Oklahoma and Texas. J. W. Brown is superintendent.

T-T Construction Co. Inc., Box 817, Tomball, Tex. *Humble Pipe Line Co.* — 20-mile, 8-in. products pipeline, first phase of a 270-mile, 6 through 10-in. between Baytown, Tex., and the San Antonio and Austin area.

Monsanto Chemical Co. — 192 miles of 3, 4 and 6-in. products lines from Texas City, Tex., to Chocolate Bayou. (This is joint venture with Monical & Powell Inc.)

Williams Bros. Co., National Bank of Tulsa Bldg., Tulsa, Okla. *Cherokee Pipe Line Co.* — 30-mile, 8-in. from Wichita Falls, Tex., where field office is located, to Temple, Okla. Superintendent: M. O. Thompson.

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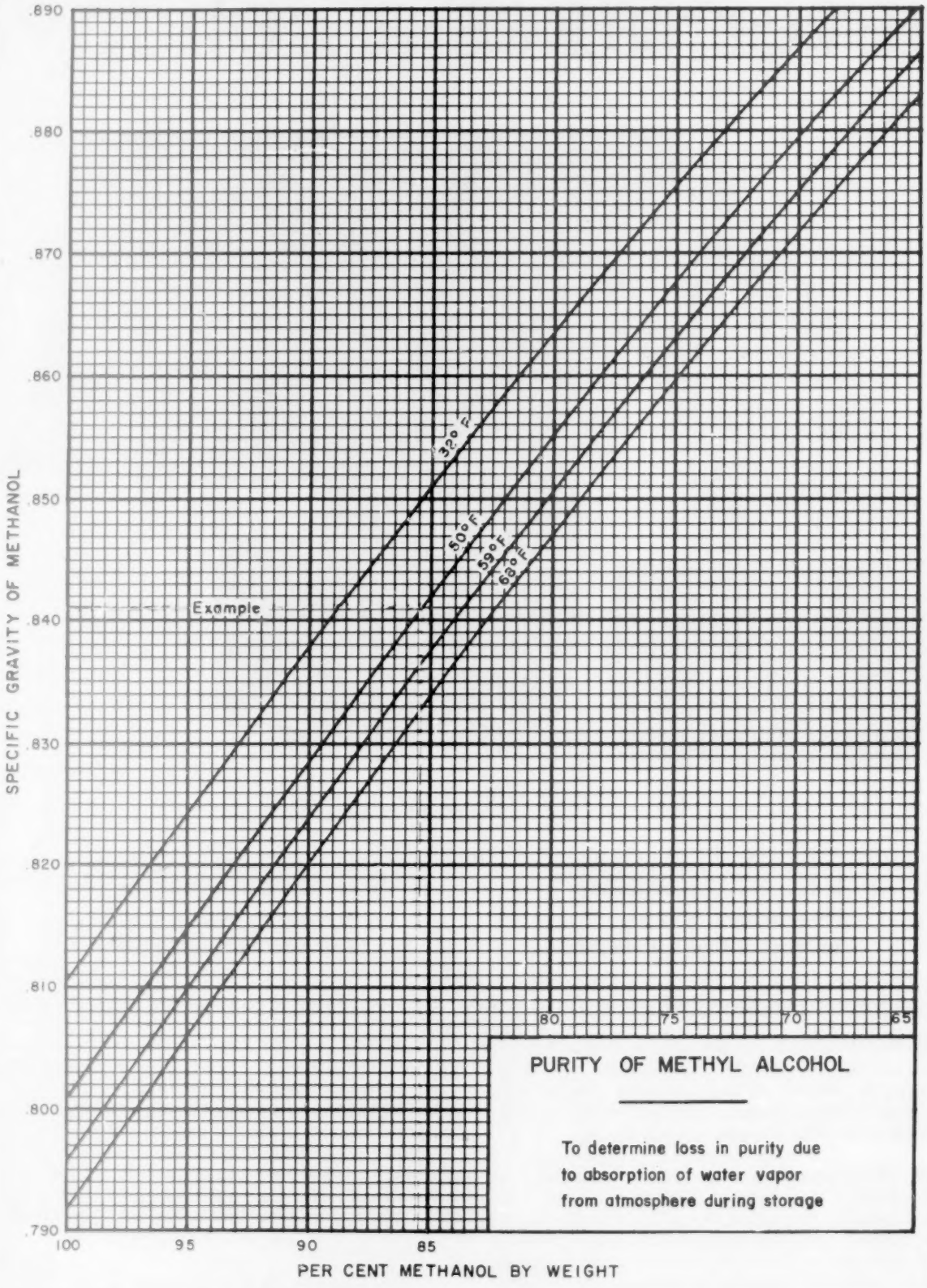

Pipeline Equipment

"Lowboy" Rectifier Welder

A new "Lowboy" silicon d-c rectifier welder for arc welding, cutting or gaging is available in two models with 60% duty cycle ratings of 200 and 300 amp. A single dial controls entire welding range. There are no moving coils or cores. Optional remote control (hand or foot operated) can be left connected and made operational by flipping remote control switch on control panel. Low design and rigid construction permit stacking. There is built-in surge protector and overload protection. *Hobart Brothers Co.*
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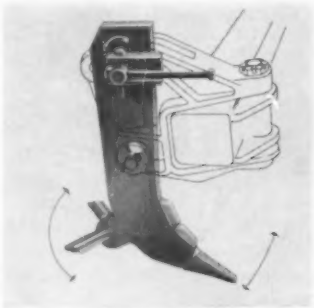
Circle number (102) on reply card



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control box and semaphore-type indicator. When protection is adequate, two 10-in. disks of the semaphore are at the same height and appear as only one black disk. When protection falls below a pre-set limit adjusted by the user, two disk flags, one black and one red, are apparent. Unit is permanently self-powered, and power lines or batteries are not needed. It may be used with any type of cathodic protection because it monitors actual pipe-to-soil potential regardless of source. *Pipetron Co.*

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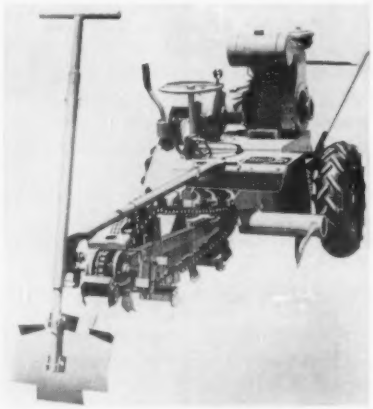
"T" Footer For Trenchers



A "T" footing cutter has been developed by The Charles Machine Works Inc. for mounting on any M3 or M4 Ditch Witch trencher, either rubber tired or crawler mounted. With this attachment, the user can dig a foundation footing with 8-in. stem and 16-in. "T" footing, which is suited to most light construction. For heavier jobs, a 12-in. stem, 24-in. "T" footing cutter which mounts on the Ditch Witch K2, 4-wheel-drive trencher, is available. *Witch Marketing Co.*

Circle number (104) on reply card

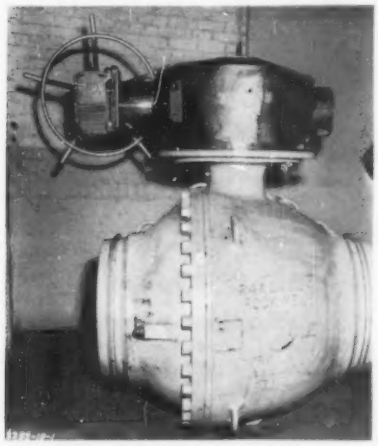
Measures Gas Density

Type 35 gas density cell provides continuous measurement of gas density in pounds per cubic foot. It produces a differential pressure directly proportional to density. This measurement, combined with pressure differential across a primary device, makes it possible to determine mass flow of gas. Gas at line static pressure is introduced into the leak-proof sampling chamber. This pressure is measured at a high pressure differential connection. A synchronous motor drives a hollow spinner in the chamber at a constant 3600-rpm. Centrifugal force produced creates a suction which draws gas through

the tube from an opening at the spinner's center. This suction pressure, varying directly with the gas density, is connected from the spinner's hub to the low pressure differential connection. The differential between the high and low pressure is a true index of gas density. The cell measures densities up to 7.8 lb per cu ft. *The Foxboro Co.*
Circle number (105) on reply card

Specially-Equipped Actuator

Rockwell Manufacturing Co. is equipping a large plug valve actuator with a Saginaw ball-bearing screw assembly for ease of operation. The actuator can be operated,



manually, electrically or pneumatically. The largest actuator is capable of applying 1,800,000 in. -lb of torque to the valve plug stem. The ball-bearing screw assembly withstands a longitudinal load of 138,000 lb and has a minimum life of 15,000 cycles when operating at speeds of from 0 to 110 rpm. Rotary motion from a hand-wheel or motor and speed-reducer is translated into linear motion of the ball nut. A yoke, attached to the nut, and connecting linkage rotates the valve-plug stem through 90 deg. *Saginaw Steering Gear Div., General Motors Corp.*
Circle number (106) on reply card

8-In. Line-Up Clamp

The first pneumatic line-up clamp for 8-in. diam line pipe is a small unit measuring only 38 in. long and weighing 80 lb. Air tank on the control rod affords a high degree of maneuverability. The unit is able to negotiate any normal degree bends. Roller shoes, with spring return, roll pipe into round. Pneumatically controlled heads operate independently on center of line principle, thus variations in pipe diameter are equalized around pipe circumference. Clamp is equipped with 325-cu-in. air reserve tank large enough to permit several line-ups without refilling. *Crutcher-Rolfs-Cummings Inc.*
Circle number (107) on reply card

Predict Hydrodynamic Torque

Hydrodynamic torque in lubricated plug valves can be predicted by a convenient method developed by Walworth. Knowing a valve's flow characteristics, one can use a simple mathematical equation to determine this torque as a function of angular plug position and to establish its maximum value. Hydrodynamic torque is that torque exerted on the plug by line fluid, which depends upon fluid density and velocity and is independent of static line pressure. It can make valve operation difficult in certain cases unless it is taken into account in the design and selection of the valve actuator. *Walworth Co.*
Circle number (108) on reply card

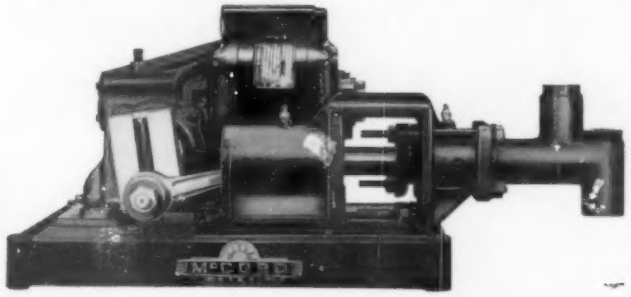
Protects Against Corrosion

A 20-mil, pressure-sensitive, polyethylene pipewrap adhesive tape has been designed for use as a heavy-duty protective coating on pipes, conduit or other surfaces. C-355, a companion to Arno's C-350 14-mil, has a black polyethylene backing especially designed for handling ease and maximum durability. A red, rubber-based, pressure-sensitive adhesive, compounded to give long-term protection, also is characteristic. Thickness combines a 16-mil film with a 4-mil adhesive. Adhesion is 40 oz per in. width. Tensile strength is 35 lb per in. width and moisture vapor transmission rate 0.18 gm per 100 sq in. in 24 hr. Dielectric strength is 1000 vpm and insulation resistance 1,000,000 megohms. *Arno Adhesive Tapes Inc.*
Circle number (109) on reply card

For Close Quarter Yard Work

A self-propelled wagon has been designed exclusively for Bucyrus-Erie's H-5 Hydrocrane, a 12-ton, ½-yd crane excavator. Rear wheel, hydraulic steering gives the H-5 wagon mounted crane extra maneuverability. Turning radius is only 22 ft. Wheelbase is 110 in., overall length 35 ft with standard 2-piece boom retracted and width 9 ft with outriggers retracted. One man can operate the unit. Outrigger housings are built into the wagon's body for better stability and overhead clearance. Manual, independent pivot lockouts on steering axle check lean-

For precision proportioning you can depend on



McCORD Type "M" Chemical Pump

In chemical processing, refining or boiler feed operations, you want dependable, precision fluid proportioning at the lowest possible cost . . . and that's *exactly* what you get with McCord's Type "M" Chemical Pump. Almost 60 models to choose from in capacities up to 170 gph, discharge pressures to 2,000 psi. And every pump in the line features: new, efficient, easily serviced valves . . . new improved packing with large stuffing box . . . interchangeable liquid ends . . . provision for flushed packing . . . all backed by McCord's more than 50 years of experience. See your McCord field engineer today.

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McCORD CORPORATION

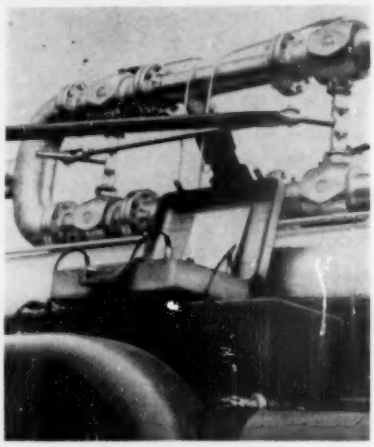
Lubrication Division • Detroit 11, Michigan

ing and sway and add stability for over-the-side lifts. An oversize Clark planetary driving axle provides a 22.35:1 gear ratio. Driving the machine is a Ford 6-cylinder, gasoline engine featuring Ford Cruise-O-Matic transmission with 3 speeds forward and 1 reverse. *Bucyrus-Erie Co.*
Circle number (110) on reply card

750-Bhp Packaged Compressor

Extending to 750 bhp the horsepower range of the Clark CFA-CFB packaged field compressor line is the new model CFB-4 completely self-contained compressor station. Built in sizes from 400 to 750 bhp, it uses a 5-in. stroke, 4-cylinder, balanced/opposed compressor with extra heavy case and running gear to accommodate the higher loading. Operating at 1000 rpm, compressor is directly connected to oil field type engine by flexible coupling. Belt and gear drives are eliminated. Because vibration is virtually eliminated, the compressor package can be mounted on any support that will hold its weight . . . barges, trailers or concrete slabs. All components are mounted on a transportable, rigid steel skid. No assembly is required at job site. *Clark Bros. Co., Div. of Dresser Industries Inc.*
Circle number (111) on reply card

Portable Electronic Counter



New solid-state electronic counter, weighing only 16 lb, was developed for use with provers in calibrating positive displacement meters. Designed for rugged field service, it is housed in a Halliburton aluminum case, 13 in. by 18 in. by 6 in. It operates either from conventional 115-v a-c power or from a 12-v vehicular storage battery. Controls are simple and connectors to prover and pulser are clearly labeled and keyed so hook-up errors are impossible. Several circuit-wise improvements enhance its operation with provers and pulsers. Counter has a special test circuit that lets operator check each decade of the five stage digital readout with additional equipment. *Datalox Div., W. W. Henry Co.*
Circle number (112) on reply card

Digital Recorder

A new transistorized, electro-mechanical recorder can print up to five 11-digit lines per sec. Storage feature allows data transfer to it in 2 milliseconds, after which driving source is released to gather more information. Internal connectors route parallel-entry data to any desired digit and different input codes may be used for each digit. Standard input is a 4-line BCD (1-2-2-4), but other 4-line codes may be used by substituting plug-in cards. Ten-line code operation is also available by card substitution and mounting additional input plugs, but no information storage is available for 10-line data. *Hewlett-Packard Co.*
Circle Number (113) on reply card

Pipeline Data Telemetering

A low-cost, digital data transmission system for the remote display and recording of information from various types of meters on pipelines

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CROSE-PERRAULT *Combination*
CLEANING & TAPE WRAPPING MACHINE

The new Crose cleaning and tape wrapping machine offers a new design and improved mechanical cleaning of pipe with twisted wire wheel type brushes revolving at high speed. Self-compensating brushes are long-wearing and economical to replace. Only one head is used, but a counter rotating effect is employed by rotation of the cleaning sprocket and an opposite rotation of wire brushes. Lower fuel consumption, less weight than comparable conventional machines. Can quickly be adjusted from one pipe size to another throughout range of machine. Handles pipe from 3" to 6".

Centrifugally loaded wheel type brush cleaning head

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is available. SD-102 Accumulated Count Data Transmission System is self-synchronizing and self-checking, with data transmitted as a 6-character decimal digit message. Transmission can be over commercial telephone lines or private AM, TONE or FSK channels. Readout may be obtained on demand or programmed automatically. The system consists of receiver and printer (central office) and any number of transmitters (remote locations). *Datex Corp.*
Circle number (114) on reply card

Has Job-Matched Speeds

Full hydraulic power steering and oil-cooled power brakes are features of the new 1¾-cu-yd capacity HD-7G tractor shovel. It is powered by a 100-hp turbo-charged diesel engine. "Ground speed control" governor allows operator to pre-set any working speed, ranging up to 5.9 mph forward and 4.2 mph reverse, to match job conditions. There is no surge of speed when load is lightened nor slow-down when it is increased. With 7 ft, 1⅝ in. of track on the ground, 62-in. wide tread and 15-in. standard shoes, the HD-7G is said to have the longest, widest undercarriage of any machine in its class-size. There is a wide variety of quick-mounted front attachments. *Allis-Chalmers Manufacturing Co.*
Circle number (115) on reply card

Cat Wheel Loader Buckets

To enable loader owners to closely match capacity to material being handled, nine new general application buckets (three types for each of three models) have been introduced for Cat wheel-type loaders — bringing to 15 the number now offered for the 966, 944 and 922 loaders. They incorporate new, extended, self-sharpening cutting edges and cast steel corner pieces welded both to cutting edge and to bucket. The five types of buckets now available for each of the three Cat wheel-type loaders are: standard, light material, reduced capacity, narrow width and standard width. *Caterpillar Tractor Co.*
Circle number (116) on reply card

Literature

Automatic Release Pipe Tongs

Automatic release pipe tongs for safer, easier pipe handling are the subject of a new revised price bulletin. Since the tongs release pipe automatically when weight is slacked off and no one is required to be near them, they are said to be ideal for pipeline construction. They are available in 3 to 36-in. pipe sizes. *C. A. Mathey Machine Works Inc.*
Circle number (117) on reply card

New PERT 7070 Packet Free

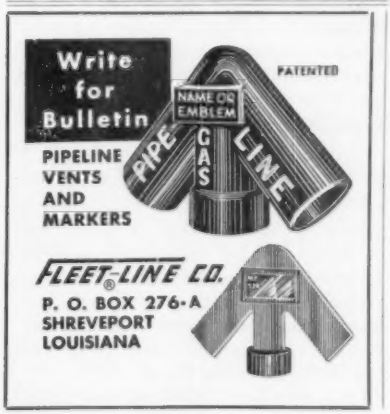
Collins has developed a PERT management scheduling and control program for use on IBM 7070 computers and is offering a "program packet" free of charge to potential users. Collins will supply a packet describing their PERT 7070 computer program which includes program deck, flow charts, logic diagrams and write-up of how their 7070 PERT system operates. Developed by the U. S. Navy, PERT (Program Evaluation and Review Technique) is said to be particularly effective for the planning and control of complex research and development programs. *Collins Radio Co., Communication and Data Systems Div.*
Circle number (118) on reply card

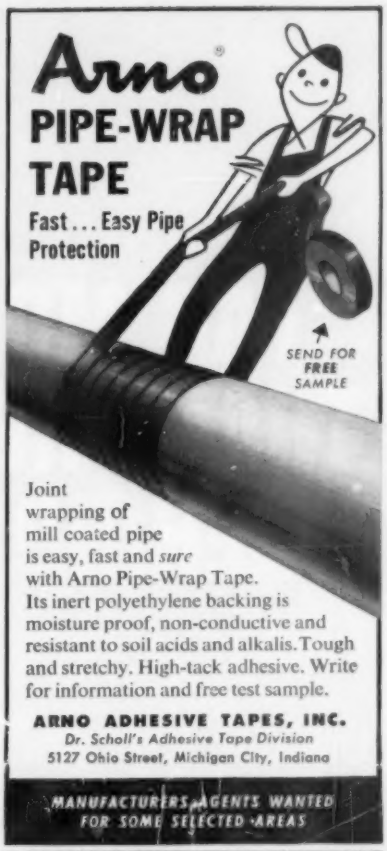
Bearing Catalog

"Bearings" is the title of a 12-page catalog covering all sizes and styles of "Life-Lube" permanently lubricated, ball-bearing pillow blocks, flange units and take-up units as well as porous-bronze and babbitted pillow blocks. New information includes a full page of babbitted bearing data on load ratings and maximum shaft speeds. New items shown are two-hole flange units, offered in shaft sizes from ½ to 1-7/16 in. *T. B. Wood's Sons Co.*
Circle number (119) on reply card

What's New in Arc Welding

No. 13 Twecolog is a catalog of electrode holders, ground clamps, cable connectors, lugs and splicers and some unusual and new items such as: jacket stripping and cable cutting hand tool that cuts copper and aluminum cable instantly; "screw-protect" that keeps screw

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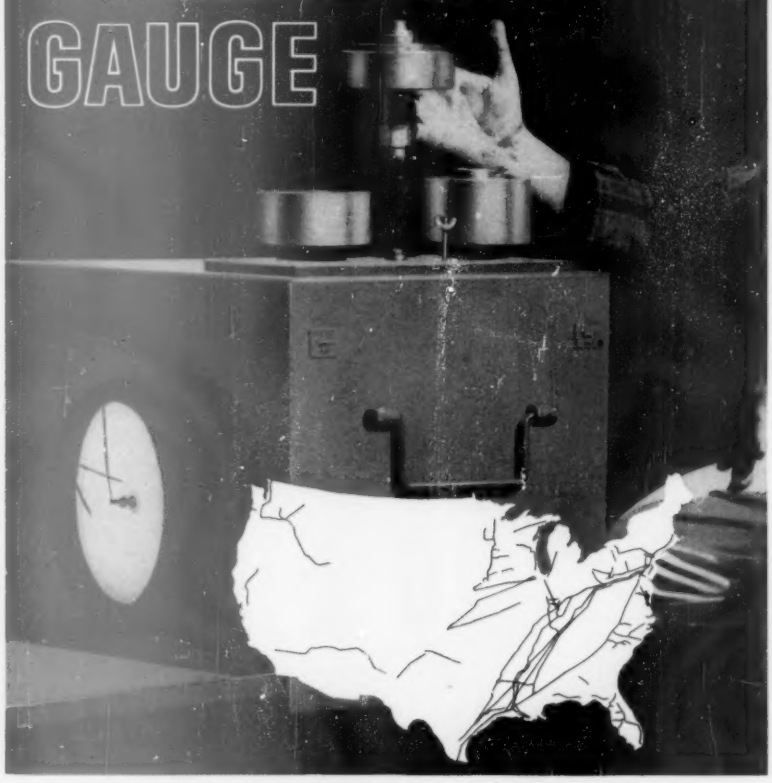
WILLIAMS HYDROSTATIC PIPELINE TESTING

FAR MORE THAN PRESSURE BEHIND THIS GAUGE



Turned slowly by hand to reduce friction, this dead weight gauge is accurate to .2%. Yet its use is just one of many techniques we've employed over the past ten years as a result of thousands of miles of testing experience. ■ Like our modern pumping equipment and advanced programming of each job, it not only provides greater accuracy . . . but lower cost testing to the pipeline company. ■ Why not let this experience save money for you on your next job? Call or write for a quotation.

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heads clean for easy removal; and "cable strand deoxidizer" that breaks down cable strand surface oxidation and cuts electrical resistance. *Tweco Products Inc.*
Circle number (120) on reply card

Transistorized Carrier Data

Highlighting a transistorized carrier brochure is a discussion of Collins' newly developed frequency generation technique which generates carrier pulses by use of a controlled delay line. This is illustrated, as well as other circuit features of the MX-106 system which can provide up to 600 voice channels over microwave radio. *Alpha Corp., Div. of Collins Radio Co.*
Circle number (121) on reply card

What Is MicroSADIC?

A 16-pager provides a technical introduction to MicroSADIC, a digital data acquisition system capable of sampling several hundred channels of analog data at up to 15,000 samples per sec. The solid state system converts analog information to equivalent digital form and records it on magnetic tape in either binary or binary-coded-decimal mode. *Consolidated Systems Corp.*
Circle number (122) on reply card

Evaporative Cooler Catalog

Evaporative coolers for cooling jacket water, lube oil, compressed air and natural gas or for condensing steam and hydrocarbons are detailed in a comprehensive 4-pager. Design features, piping diagrams of sample units and dimensional drawings and tables are presented. *Young Radiator Co.*
Circle number (123) on reply card

Construction Line Folder

Illustrations and condensed specifications on two crawler tractor models, eight scrapers, nine rear-dump haulers and three bottom-dump models are contained in a new 20-page Euclid line booklet. *Euclid Div., General Motors.*
Circle number (124) on reply card

Catalog on Large Antennas

Large parabolic antennas are covered in an 8-page catalog which discusses the new Hubloc construction which provides added strength and stiffness while reducing weight. Specifications on 28 and 60-ft diam reflectors are given with information on antenna feeds, reflector surfaces, supports, mounts and radomes. *Andrew Corp.*
Circle number (125) on reply card

Pipeline People

S. D. Whiteman has been named board chairman and chief executive officer of Kansas-Nebraska Natural Gas Co. He is replaced as president and principal operating officer by Thomas Creigh Jr., formerly vice president in charge of production, transmission and gas supply. Frank Flagg has been moved from the discontinued office of executive vice president to financial vice president. New vice presidents are: Frank Soldan, merchandising, formerly general sales manager; Fred Steffens, also secretary and controller; and Stephen D. Ford Jr., production and gas supply, formerly chief engineer. New chief engineer is James Asbury, and John Ashburn has been promoted to senior engineer.

Alan M. McRae succeeds the late T. R. Scott as manager of Winnipeg Pipe Line Co. Ltd. Prior to his appointment, McRae was operations superintendent of Sarnia Products Pipe Line.

Tidewater Oil Co. has appointed Arthur G. Meck manager of its eastern division pipeline department. Meck will go to New York from Watson, Calif., where he has been serving as area supervisor in the western division pipeline system.

Harry Lee has been appointed assistant general superintendent of Ohio Fuel Gas Co.'s gas measurement department. He has been acting as assistant to M. P. Debaets, gas measurement superintendent.

Reassignments in Magnolia Pipe Line Co. include: Rex C. Kelsey, from temporary chief pipeline inspector, Algeria, to construction foreman, Houston pipeline division; Edward Golobich, from assistant construction foreman, East Douglas area, to construction foreman, Harrisburg area, Plainfield pipeline division; F. L. Johns, from station foreman, Gainesville station, Midland division, to gager foreman, Karnes gathering system, Alice district, Houston division; E. F. Zelaznowski, from first-class welder to assistant construction foreman, East Douglas area, Plainfield division; John F. Erbel, from second-class welder to first-class welder, Harrisburg area, Plainfield division; Carl G. Wilkins, from Paulsboro, N. J., refinery to engineering draftsman, Wichita pipeline division; Herman W. Shaw, station foreman, from Wichita division to Gainesville station, Midland division; and Donald C. Stayer, from pipeliner, Plainfield division, to Philadelphia marketing division.

Dr. H. R. Linden

New director of the Institute of Gas Technology is Dr. Henry R. Linden, formerly research director. He succeeds Dr. Martin A. Elliott, newly-named academic vice president of Illinois Institute of Technology, an IGT affiliate. Elliott will continue to serve as executive consultant to IGT. Linden, prior to his association with IGT, was with Socony Mobil Oil Co.

Promoted from assistant to manager of rates for Texas Gas Transmission Corp. is Melvin H. Rattray Jr. He will prepare and process all company rate schedules and file service agreements between Texas Gas and its customers with the Federal Power Commission.

Promotions and transfers for eight supervisory employees in Northern Natural Gas Co.'s operating division result from the retirement of Dewey Rice as superintendent of integrated operations at Clifton, Kan.

Taking over Rice's duties at Clifton is Roy Spratt, formerly plant superintendent at Palmyra, Neb. Replacing Spratt is Dale Kullbom,

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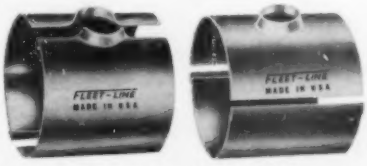

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formerly plant superintendent at Hugoton, Kan. Eutah York moves from plant superintendent at Holcomb, Kan., to replace Kullbom. York is replaced by John Scoville, formerly compressor and processing plants superintendent at Spearman, Tex. C. M. Floyd has been transferred to the Spearman, Tex., post and is replaced as superintendent of integrated operations at Garden City, Kan., by Harold Carr, formerly district pipeline superintendent at Ogden, Iowa. Irvin Webb, formerly district pipeline superintendent at Garden City, Kan., replaces Carr at Ogden. Perry Moore, formerly field dispatcher coordinator at Hugoton, replaces Webb.

Guenther Einsel and Erhard Tamchina have been appointed business managers of Rhein-Donau Oelleitung GmbH, the firm in charge of laying and operating the Bavarian pipeline. Einsel already has taken a leading part in the laying of the Rotterdam-Rhine pipeline.

Walter E. Caine, Texas Eastern Transmission Corp. vice president in charge of gas sales, has been named to the newly-organized committee on gas requirements and supply, working through the general management section of the American Gas Association.

J. B. Henderson

James B. Henderson has been named executive vice president of Transcontinental Gas Pipe Line Corp. He has been Transco's vice president and general counsel for 12 years and is a member of the board of directors. He will continue to serve in the dual capacity of director and officer.

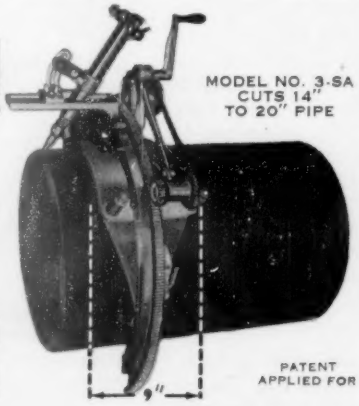
The API Div. of Transportation has named those who are to receive Certificates of Appreciation at the institute's 41st annual meeting. They are: L. C. Davidson, Cities Service Petroleum Co.; L. M. Jonassen, Cleveland Tankers Inc.; Robert Maguire, The Atlantic Refining Co.; R. K. Paine, Standard Oil Co. of California; R. L. Ransome, Shell Pipe Line Co.; B. E. Rogers, Richfield Oil Corp.; D. F. Sears, Shell Pipe Line Co.; and R. M. Slough, Marathon Pipe Line Co.

Michigan Wisconsin Pipe Line Co. and American Louisiana Pipe Line Co. have elevated one vice president and elected two new ones. New vice presidents of their respective companies are Charles J. McInerney, secretary of Michigan Wisconsin, and W. Arthur Batten, secretary of American Louisiana. Robert M. Hoffer, vice president and controller of both, is now financial vice president of both.

Holly F. Bradley, safety supervisor for Service Pipe Line Co., has been elected for a 3-year term to the executive committee of the 7300-member American Society of Safety Engineers. Also, Service has transferred Lyle H. Brandt, division gager, from Pauls Valley, Okla., to Rawlins, Wyo.

Frank Rivers has joined Northern Natural Gas Co. as rate and tariff department director. He most recently was manager of the rate department of Texas Gas Transmission Corp. and, prior to that, was employed for 14 years by the Federal Power Commission. He also has served the Federal Communications Commission as rate investigation auditor.

NEW!



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MOUNTS AND CUTS ON SHORT LENGTHS OF PIPE!

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- Retains extreme accuracy of cuts, which all Mathey Pipe Beveling Machines are noted for.
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Pipeline Parade

The Sooner Tractor Co., Tulsa, Okla., is a new construction and pipeline equipment firm. It assumes distribution of Allis-Chalmers construction machinery in 28 counties of North and East Oklahoma. Principals are: Christian "Nick" Seger, president, formerly an officer of Lucey Products and still a director of that organization; G. E. "Scotty" Caswell, vice president, formerly with Tulsa Equipment Co.; and John E. Kirkpatrick, treasurer, also president of Kirkpatrick Oil Co. Office manager is J. Ray Huffine, formerly with Tulsa Tractor Co. and, prior to that, an operating partner in Tulsa Equipment Co.

Worthington Corp. has appointed three new distributors of mechanical power transmission products: Girardi Bearing Co., 257 John St., Salinas, Calif.; Ress Machine & Supply, 221-223 South 9th St., Lincoln, Neb.; and Top Power Equipment Co. Inc., 202 Industrial St., Kilgore, Tex.

Parsons Co. has appointed Midwestern Engine & Equipment Co. Inc., Tulsa, Okla., as distributor to service interstate and international accounts. It will handle the complete line of Parsons Trenchliners. In addition, it handles Ka-Mo products manufactured by Kwik-Mix Co., another Koehring Co. division.

The F. H. Maloney Co. has launched a $650,000 plant expansion program to add about 48,000 sq ft, in two buildings, to its Houston, Tex., facilities. The new buildings will house a production line for meter provers and launchers and permit expansion of virtually all the rest of the firm's departments involved in plastics, metal and rubber product manufacturing.

Republic Steel Corp.'s steel and tubes division has opened new sales offices in Tulsa, Okla., and Houston, Tex. R. E. Hornak will manage the former, which will encompass Oklahoma, seven Kansas counties, 15 Missouri counties and, for electrical tubular products only, most of Arkansas. W. L. Garay will manage the Houston sales district which will cover Texas, New Mexico and the western tier of counties in Louisiana.

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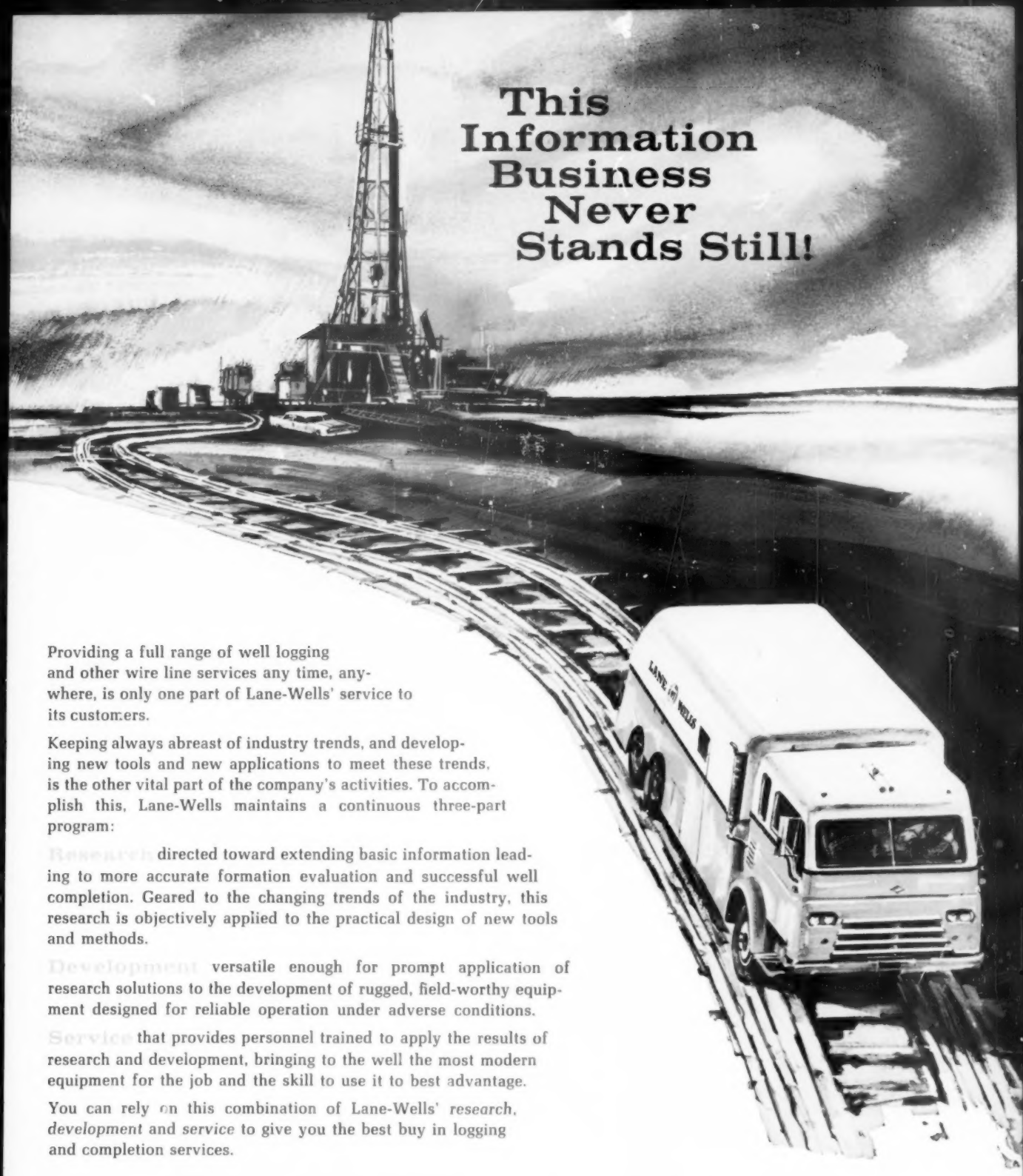

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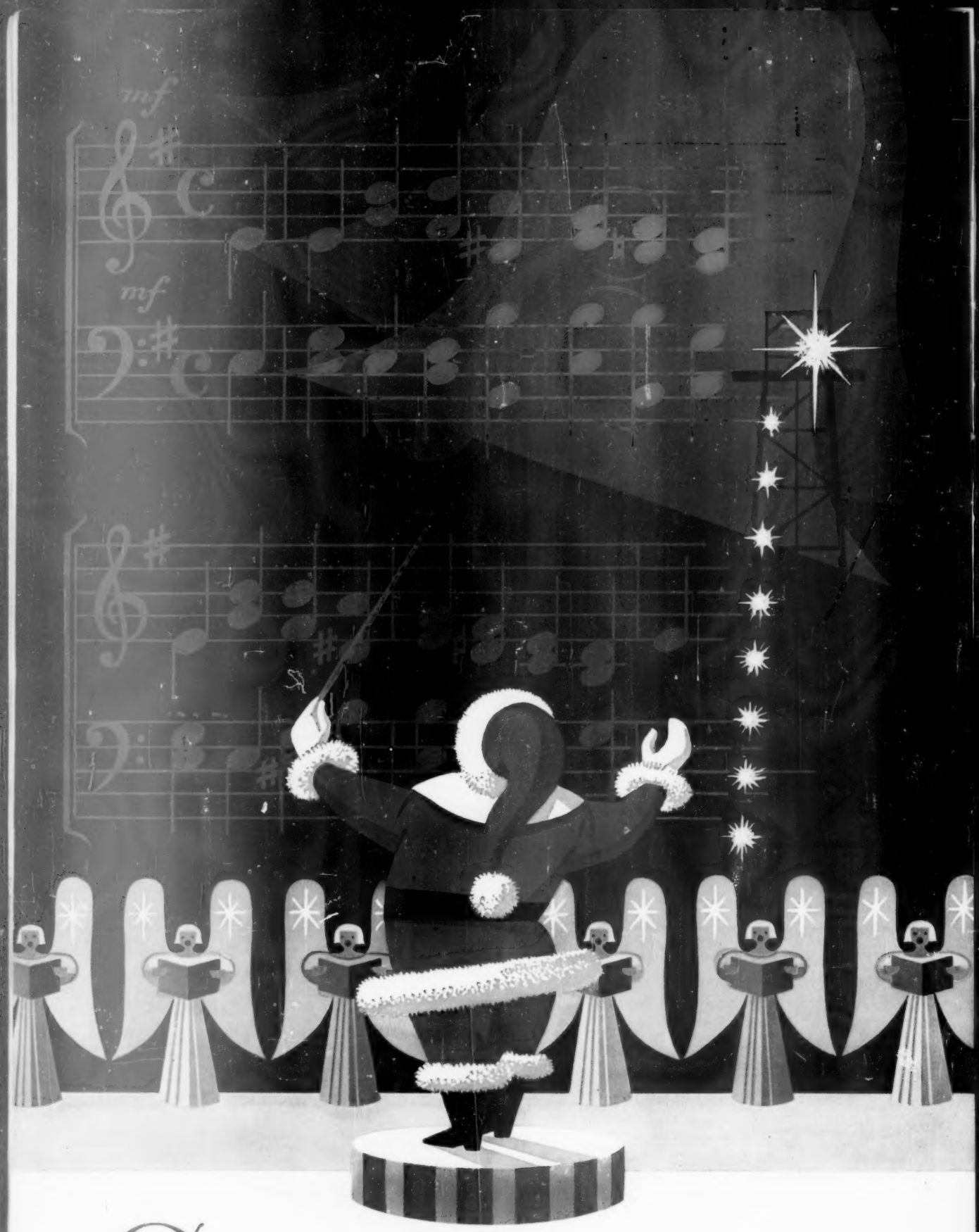

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